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# 1979 Ames Research Center Publications: A Continuing Bibliography

Evaluation of the Tilt Rotor Concept: The XV-15's Role. Future Requirements and Roles of Computers in Aerodynamics of Viscous Flows. A Simple Method for Estimating Minimum Autorotative Descent Rate of Single Rotor Helicopters. Dynamic Stability Analysis of the Space Shuttle Vehicle-Orbiter. Comparison of Measured and Calculated Helicopter Noise. Effect of High Lift Flap Systems on the Conceptual Design of a 1985 Short-Haul Commercial Jet. Multicyclic Control by Swashplate Oscillation. Low-Speed Aerodynamic Characteristics of a Helicopter Model at High Angles of Attack and Sideslip. Generalization of Huffman Coding to Minimize Optimum Horizontal Guidance Techniques for Aircraft. Quasi-Optimal Control of a Moving Vehicle and Control for Investigating Aircraft Noise-Impact Reduction. Trajectory Module of the Aircraft Synthesis Program ACSYNT. A Flight Investigation of the Stability, Control, and Handling Qualities of an Augmented Jet Flap STOL Airplane. G-Seat System Step Input and Sinusoidal Response Characteristics/Performance Measurement System on a Research Aircraft Project. Application of Special-Purpose Aircraft Real-Time Simulation. Wing Analysis Using a Transonic Potential Flow Computational Method. Hardware Analysis. Phenomenological Aspects of Quasi-Stationary Controlled and Uncontrolled Flow Separations. A Method for the Analysis of the Benefits and Costs for Aeronautical Research. CTOL Aircraft Research. Closed-Form Equations for the Lift, Drag, and Pitching-Moment Coefficients. Maneuverable Transonic Aircraft. Synergies from Four Helicopter Rotor Bladeforce Analysis. Multi-Calculation of the Three Stage Compression-Ratio Propulsion System. A Harrier V-STOL Reentry Problem. Model Volume 2: Configuration of Advanced Turboprop T-Rotor in a Wind Tunnel. Applied to a Helicopter in the Wind Tunnel. Automatic and Manual Flight Director Law. XV-15 Tilt Rotor Aircraft in Helicopter Mode. Application of Advanced Technologies to Small Short-Haul Airplanes. Large Scale Swivel Nozzle Thrust Deflector. High Angle Canard Missile Test in the Ames 11-Foot Wind Tunnel. Study of Commuter Airplane Design Optimization. Application of Second-Order Turbulent Modeling to Radiated Aerodynamic Sound. Infrastructure Dynamics: A Selected Bibliography. The Effect of Tip Vortices on Helicopter Noise Due to Blade-Vortex Interaction. A Study of Test Section Configuration for Shock Tube Measurements. A Mach Line Panel Method for Computing the Linearized Supersonic Flow Over Planar Wings. An Evaluation of Short Haul Air Transportation in the Southeastern United States. Development and Flight Tests of Navigation During Terminal Area and Landing Operations. Prop-Fan Data Support Study. Study to Determine Operational and Performance Criteria for STOL Aircraft Operating in Low Visibility Conditions. Executive Summary of an Intra-Regional Air Service in the Bay Area. Technology Assessment of Transportation System Investments. Requirements for Regional System. Phase 1: A Preliminary Assessment of a Flight Program to Determine Neighborhood Reactions to Small Transport Aircraft. Phase 2: A Preliminary Flight Data Analysis. Velocity Response at Subsonic and Transonic Speeds. Phase 3: A Final Flight Data Analysis. Velocity Response at Subsonic and Transonic Speeds. Phase 4: A Final Flight Data Analysis.

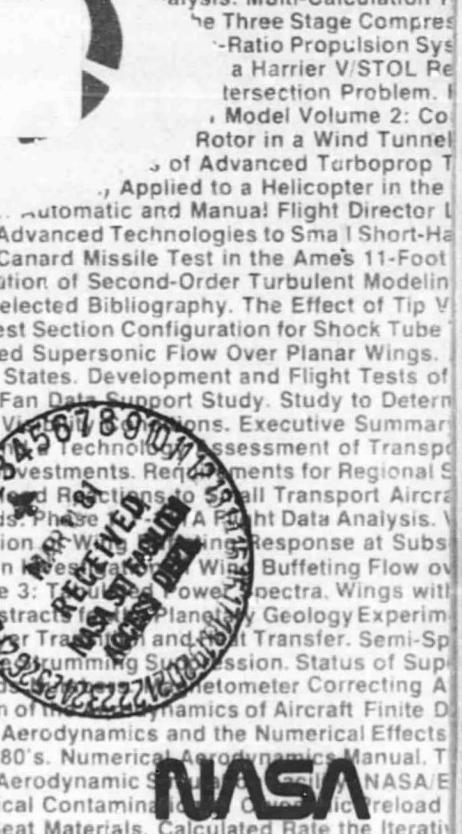
(NASA-TM-81257) THE 1979 AMES RESEARCH CENTER PUBLICATIONS: A CONTINUING BIBLIOGRAPHY (NASA) 319 p HC A14/MF A01

N81-17944

CSCL 05B

Unclassified

G3/82 41420



Boundary Layers at Large Reynolds Numbers. Simple Torsion Test for Shear Moduli Determination of Orthotropic Composites. Future Fluidic Stall of an Oscillating Airfoil. A Review of NASA-Sponsored Technology Assessment Projects. Lagrangian Bimolecular Reimputation of Inviscid Compressible Flows. Engineering Tests of the C-141 Telescope. Calculation of Supersonic Viscous Properties of an 0.075-Scale F-15 Airplane Model at High Angles of Attack and Sideslip. Response at Subsonic and Transonic Testing with Spitter Plates. Phenomenological Aspects of Quasi-Stationary Controlled and An Investigation of Wing Bu-

1979

**Ames Research Center Publications:  
A Continuing Bibliography**



National Aeronautics and  
Space Administration

**Ames Research Center**  
Moffett Field, California 94035

## FOREWORD

This seventh annual edition of *Ames Research Center Publications: A Continuing Bibliography* lists Ames-sponsored literature indexed during 1979 in *Scientific and Technical Aerospace Reports* (STAR), *Limited Scientific and Technical Aerospace Reports* (LSTAR) and *International Aerospace Abstracts* (IAA).

The Bibliography is divided into two sections: Section I contains citations and abstracts of published works listed by directorate, type of publication (NASA formal report, NASA contractor report, journal article, meeting paper, book or chapter of a book, and patents); Sections II and III are comprised of subject, author, contract number and report number indexes.

Information for ordering publications cited may be obtained by referring to NASA's STAR, LSTAR, and IAA. The NASA unlimited reports are available in either hard copy or microfiche through the National Technical Information Service (NTIS), Springfield, VA 22151, or through the Government Printing Office (GPO), Washington, D.C. 20402. Items identified with an X accession number are often limited or classified and available only to certain individuals or organizations. These documents must be ordered from the NASA center or from the institution which produced them. Patents are available through the Commissioner of Patents, U.S. Patent Office, Washington, D.C. 20231.

The Library Branch Staff is available to advise Ames requestors which form, ARC 80 "Library Resource Request" or ARC 81 "Published Material Request," should be used to order copies of published works from either the Ames Technical Library, 202-3, extension 5157, or the Life Sciences Library, 239-13, extension 5387.

Because this edition of *Ames Research Center Publications: A Continuing Bibliography* is based upon the indexing services of STAR, LSTAR, and IAA, some published work may not be included. If this is the case, send two copies of the published work to Betty Sherwood, 202-3, and the citation will appear in the next annual bibliography.

Betty Sherwood, Compiler

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**SECTION I**  
**PUBLICATIONS**

## OFFICE OF THE DIRECTOR

### FORMAL REPORTS

N79-10842# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PLANNING FOR AIRPORT ACCESS: AN ANALYSIS OF THE SAN FRANCISCO BAY AREA**

Jarir S. Dajani, ed. (Stanford Univ., Calif.), James V. Jucker, ed., and J. Lloyd Jones (Stanford Univ.) May 1978 300 p refs Stanford-NASA-ASEE Summer Faculty Fellowship Program on Eng. System Design held at Moffett Field, Calif., 1977 (Grant NGR-05-020-409) (NASA-CP-2044; A-7347) Avail: NTIS HC A13/MF A01 CSCL 13F

A description of the airport area, its current transportation capabilities, and recommendations for future access planning are presented. For individual titles, see N79-10943 through N79-10948.

N79-10897# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**TECHNOLOGICAL CHANGE AND PRODUCTIVITY GROWTH IN THE AIR TRANSPORT INDUSTRY**

Nathan Rosenberg (Stanford Univ., Calif.), Alexander Thompson (Stanford Univ., Calif.), and Steven E. Belsley Sep. 1978 101 p refs (NASA-TM-78505; A-7514) Avail: NTIS HC A06/MF A01 CSCL 02A

The progress of the civil air transport industry in the United States was examined in the light of a proposal of Enos who, after examining the growth of the petroleum industry, divided that phenomenon into two phases, the alpha and the beta; that is, the invention, first development and production, and the improvement phase. The civil air transport industry developed along similar lines with the technological progress coming in waves; each wave encompassing several new technological advances while retaining the best of the old ones. At the same time the productivity of the transport aircraft as expressed by the product of the aircraft velocity and the passenger capacity increased sufficiently to allow the direct operating cost in cents per passenger mile to continually decrease with each successive aircraft development.

LS

N79-11984# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AMES COLLABORATIVE STUDY OF COSMIC-RAY NEUTRONS. 2: LOW- AND MID-LATITUDE FLIGHTS**

L D Stephens, J B. McCaslin, A. R. Smith, R. H. Thomas, J. E. Hewitt, and L Hughes 1 Mar. 1978 20 p refs Prepared in cooperation with California Univ., the Lawrence Berkeley Lab. (Contract W-7405-eng-48) (NASA-TM-79881; LBL-6738) Avail: NTIS HC A02/MF A01 CSCL 03B

D  
Progress of the study of cosmic ray neutrons is described. Data obtained aboard flights from Hawaii at altitudes of 41,000 and 45,000 feet, and in the range of geomagnetic latitude 17 N less than or equal to lambda less than or equal to 21 N are reported. Preliminary estimates of neutron spectra are made.

DOE

N79-15887# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**HUMAN NEUROLOGICAL DEVELOPMENT: PAST, PRESENT AND FUTURE**

Ralph Pelligra, ed. Nov. 1978 60 p refs Symp. held at Moffett Field, Calif., 18 May 1978; sponsored in part by Inst for the Achievement of Human Potential, Philadelphia, Pa. Original contains color illustrations (NASA-CP-2063; A-7630) Avail: NTIS HC A04/MF A01 CSCL 06P

Neurological development is considered as the major human potential. Vision, vestibular function, intelligence, and nutrition are discussed as well as the treatment of neurological dysfunctions, coma, and convulsive seizures. For individual titles, see N79-15888 through N79-15897.

N79-15983# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**VISUAL SIMULATION REQUIREMENTS AND HARDWARE**  
John C. Dusterberry /n AGARD Piloted Aircraft Environ. Simulation Tech. Oct. 1978 7 p refs /or primary document see N79-15973 07-09)

Avail: NTIS HC A14/MF A01 CSCL 01E

Requirements for any out-of-the-cockpit visual simulation system can easily lead to a set of system specifications which are clearly beyond the visual scene that can be produced by current technology. Therefore, the requirements of any proposed system must be assessed in light of the expected simulated aircraft and missions, experiments on pilot response, and available image generation and display hardware. A review is made of some of the recent experiments, and the results are related to aircraft and missions with particular emphasis on research and development simulators. Recent visual simulation hardware is considered in light of extending the range of applications of piloted aircraft simulators, and a method of design approach is proposed.

G.Y.

## NASA CONTRACTOR REPORTS

X79-10063\*# Public Service Consultants, Seattle, Wash.  
**RATE DESIGN FOR CENTRAL VALLEY PROJECT,  
PROJECTION OF FUTURE CUSTOMER USAGE FOR THE  
PERIOD TWELVE MONTHS ENDED JUNE 30, 1975, AND  
ANALYSIS OF CUSTOMER USAGE FOR THE PERIODS OF  
TWELVE MONTHS ENDED JUNE 30, 1973, 1974, 1975,  
1976, AND 1977**

24 Oct 1978 143 p Sponsored by NASA Prepared for DOE  
(NASA-CR-152215) Unclassified report

NOTICE Available to U.S. Government Agencies and Their Contractors.

D Three alternative rate structures, other than the traditional average rate to all Central Valley Project commercial power customers, are reviewed. Under the recommended rate structure C, customers who purchase only project-generated power would pay the project supply charges. Those customers requiring power over and above the amount available to them from the project would pay dual charges. Tentative rates for rate structure C are 1.18 kW/mo demand charge and 3.60 mills kWh energy charge for project supply. For purchase supply, the demand charge is 2.40 kW/month and 13.92 energy charge. A R H

## JOURNAL ARTICLES, BOOKS AND CHAPTERS OF BOOKS

A79-51027 \* Aerospace highlights and potential medical applications. C. A. Syvertson (NASA, Ames Research Center, Moffett Field, Calif.). In: Noninvasive cardiovascular measurements. (A79-51026 23-54) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 1-10.

An attempt is made to provide an overview of activities going on in NASA from aeronautics to manned space flight, to exploration of other planets. Some of the spin-offs of NASA research related to the medical profession are described. The discussion focuses on the Space Shuttle, the unmanned spacecraft Seasat program, the exploration of other planets in the solar system, a water-cooled helmet, and some breakthroughs in medical diagnostic instrumentation. S.D.

# ADMINISTRATION

## FORMAL REPORTS

N79-15888\*# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**TECHNOLOGY UTILIZATION** c85  
Charles C. Kubokawa / In its Human Neurol. Develop. Nov.  
1978 p 5-7 (For primary document see N79-15887 06-89)  
Avail: NTIS HC A04/MF A01 CSCL 05A

NASA developed technologies were used to tackle problems associated with safety, transportation, industry, manufacturing, construction and state and local governments. Aerospace programs were responsible for more innovations for the benefit of mankind than those brought about by either major wars, or peacetime programs. Briefly outlined are some innovations for manned space flight, satellite surveillance applications, and pollution monitoring techniques.

G.G.

N79-22867\* National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**AMES RESEARCH CENTER PUBLICATIONS, 1977**  
Apr. 1979 123 p  
(NASA-TM-78514: A-7704) Avail: NTIS HC A06/MF A01  
CSCL 05B

This bibliography lists 786 formal NASA publications, journal articles, books, chapters of books, patents, and contractor reports which appeared during 1977 or which were not included in previous annual bibliographies. Citations are arranged by directorate, type of publication, and author. Each NASA report is identified by a technical report and accession number to facilitate ordering. An author index is provided.

A.R.H.

A

## NASA CONTRACTOR REPORTS

N79-12861\*# SRI International Corp., Menlo Park, Calif.  
**SUGGESTED APPROACH FOR ESTABLISHING A REHABILITATION ENGINEERING INFORMATION SERVICE FOR THE STATE OF CALIFORNIA**

Lo F. Christy, Gail Kelton-Fogg, Ruth Lizak, and Cynthia Vahlkamp  
Sep. 1978 250 p refs Sponsored in part by California State Dept. of Rehabilitation  
(Contract NAS2-9846: SRI Proj. MEU-7171)  
(NASA-CR-152198) Avail: NTIS HC A11/MF A01 CSCl  
05B

An ever expanding body of rehabilitation engineering technology is developing in this country, but it rarely reaches the people for whom it is intended. The increasing concern of state and federal departments of rehabilitation for this technology led was the stimulus for a series of problem-solving workshops held in California during 1977. As a result of the workshops, the recommendation emerged that the California Department of Rehabilitation take the lead in the development of a coordinated delivery system that would eventually serve the entire state and be a model for similar systems across the nation.

G.Y.

# AERONAUTICS AND FLIGHT SYSTEMS

## FORMAL REPORTS

N79-10046# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

### FLIGHT RESEARCH CAPABILITIES OF THE NASA/ARMY ROTOR SYSTEMS RESEARCH AIRCRAFT

Samuel White, Jr. and Gregory W. Condon Sep. 1978 30 p refs

(NASA-TM-78522; A-7602) Avail: NTIS HC A03/MF A01 CSCL 01C

A description is given of the capabilities and limitations of the Rotor Systems Research Aircraft (RSRA) that was demonstrated during the development contract, and assesses the expected research capabilities of the RSRA on delivery to the government.

L.S.

N79-10054# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

### FLIGHT EXPERIENCE WITH ADVANCED CONTROLS AND DISPLAYS DURING PILOTED CURVED DECELERATING APPROACHES IN A POWERED-LIFT STOL AIRCRAFT

W. S. Hindson (Natl. Aeron. Estab., Ottawa) and G. H. Hardy Sep. 1978 14 p refs

(NASA-TM-78527; A-7625) Avail: NTIS HC A02/MF A01 CSCL 01D

The control, display, and procedural features are described for a flight experiment conducted to assess the feasibility of piloted STOL approaches along predefined, steep, curved, and decelerating approach profiles. It was found to be particularly important to assist the pilot through use of the flight director computing capability with the lower frequency control-related tasks, such as those associated with monitoring and adjusting configuration trim as influenced by atmospheric effects, and preventing the system from exceeding powerplant and SAS authority limitations. Many of the technical and pilot related issues identified in the course of this flight investigation are representative of similarly demanding operational tasks that are thought to be possible only through the use of sophisticated control and display systems.

A.R.H.

N79-11034# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif

### AN OVERVIEW OF THE QUIET SHORT-HAUL RESEARCH AIRCRAFT PROGRAM

Michael D. Shovlin and John A. Cochrane Nov 1978 41 p refs

(NASA-TM-78545; A-7672) Avail: NTIS HC A03/MF A01 CSCL 01C

An overview of the Quiet Short Haul Research Aircraft (QSRA) Program is presented, with special emphasis on its propulsion and acoustic aspects. A description of the NASA technical participation in the program including wind tunnel testing, engine ground tests, and advanced aircraft simulation is given. The aircraft and its systems are described and, measured performance, where available, is compared to program goals. Preliminary data indicate that additional research and development are needed in some areas of which acoustics is an example. Some of these additional research areas and potential experiments using the QSRA to develop the technology are discussed. The concept of the QSRA as a national flight research facility is explained.

N79-12013# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

### APPLICATION OF SHOCK TUBES TO TRANSONIC AIRFOIL TESTING AT HIGH REYNOLDS NUMBERS

William J. Cook (Iowa State Univ.), Michael J. Chaney (Iowa State Univ.), Leroy L. Presley, and Gary T. Chapman Nov. 1978 69 p refs

(NASA-TP-1268; A-6855) Avail: NTIS HC A04/MF A01 CSCL 01A

Performance analysis of a gas-driven shock tube shows that transonic airfoil flows with chord Reynolds numbers of the order of 100 million can be produced, with limitations being imposed by the structural integrity of the facility or the model. A study of flow development over a simple circular arc airfoil at zero angle of attack was carried out in a shock tube at low and intermediate Reynolds numbers to assess the testing technique. Results obtained from schlieren photography and airfoil pressure measurements show that steady transonic flows similar to those produced for the same airfoil in a wind tunnel can be generated within the available testing time in a shock tube with properly contoured test section walls.

G.G.

N79-12018# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

### EXPERIMENTAL INVESTIGATION OF WING FIN CONFIGURATIONS FOR ALLEVIATION OF VORTEX WAKES OF AIRCRAFT

Vernon J. Rossow Nov. 1978 38 p refs  
(NASA-TM-78520; A-7593) Avail: NTIS HC A03/MF A01 CSCL 01A

A variety of fin configurations were tested on a model of the Boeing B747 in 40 by 80 foot wind tunnels. The test results confirmed that a reduction in wake rolling moment was brought about by the vortex shed by the fins so that a wide range of designs can be used to achieve wake alleviation. It was also found that the reduction in wake-induced rolling moments was especially sensitive to the location of the smaller fins on the wing and that the penalties in lift and drag can probably be made negligible by proper fin design.

J.A.M

N79-12019# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

### COMPREHENSIVE HELICOPTER ANALYSIS: A STATE OF THE ART REVIEW

Wayne Johnson Nov. 1978 18 p refs Prepared in cooperation with Army Aviation Research and Development Command, Moffett Field, Calif.

(NASA-TM-78539; AVRACOM-78-56(AM); A-7681) Avail: NTIS HC A02/MF A01 CSCL 01A

An assessment of the status of helicopter theory and analysis is presented. The technology level embodied in available design tools (computer programs) is examined, considering the problem areas of performance, loads and vibration, handling qualities and simulation, and aerelastic stability. The effectiveness of the present analyses is discussed. The characteristics of the technology in the analyses are reviewed, including the aerodynamics technology, induced velocity and wake geometry, dynamics technology, and machine limitations.

Author

N78-12621#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.  
**CANARD-BODY-TAIL MISSILE TEST AT ANGLES OF  
ATTACK TO 60 DEG IN THE AMES 11-FOOT TRANSONIC  
WIND TUNNEL.**

Clyde Q. Allen, Richard G. Schwind (Nielsen Eng. and Res., Inc., Mountain View, Calif.), and Gerald N. Malcolm Sep. 1978  
1217 p refs

(NASA-TM-78441) Avail: NTIS HC A99/MF A01 CSCL 01A  
Blunted ogive cylinder missile models with a length-to-diameter ratio of 10.4 were tested at transonic speeds and large angles of attack in an 11 foot transonic wind tunnel. The configurations are: body, body with tail panels, body with canards, and body with canards and tails. Forces and moments from the entire model and each of the eight fins were measured over the pitch range of 20 deg to 50 deg, and roll angles of 0 deg to 45 deg and canard deflection angles between 0 deg and 15 deg. The Reynolds number ranged from  $3.9 \times 10^6$  to the 6th power per meter. Large side forces and yawing moments were observed for some of the test cases involving a symmetric geometry. B.B.

N78-12642#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**NONLINEAR DYNAMIC RESPONSE OF WIND TURBINE  
ROTORS Ph.D. Thesis - MIT**

Inderjit Chopra Feb. 1977 233 p refs

(Grant NSF AER-75-00826)

(NASA-TM-78324) Avail: NTIS HC A1/MF A01 CSCL 10A  
The nonlinear equations of motion for a rigid rotor restrained by three flexible springs representing the flapping, lagging and feathering motions are derived using Lagrange's equations for arbitrary angular rotations. These are reduced to a consistent set of nonlinear equations using nonlinear terms up to third order. Author

N78-12666#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**AIR POLLUTION FROM AIRCRAFT OPERATIONS AT SAN  
JOSE MUNICIPAL AIRPORT, CALIFORNIA**

Edward T. Schairer Nov. 1978 23 p refs

(NASA-TM-78506; A-7523) Avail: NTIS HC A03/MF A01  
CSCL 13B

The amount of air pollution discharged by arriving and departing aircraft at the San Jose Municipal Airport was estimated. These estimates were made for each one hour interval of a summer weekday in 1977. The contributions of both general aviation (personal and business aircraft) and certified air carriers (scheduled airliners) were considered. The locations at which the pollutants were discharged were estimated by approximating the flight paths of arriving and departing aircraft. Three types of pollutants were considered: carbon monoxide, hydrocarbons, and oxides of nitrogen. S.B.S.

N78-12687#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**A NONLINEAR TRAJECTORY COMMAND GENERATOR  
FOR A DIGITAL FLIGHT-CONTROL SYSTEM**

Luigi S. Ciccolani and Stein Weissenberger Nov. 1978 114 p refs

(NASA-TP-1221; A-7074) Avail: NTIS HC A08/MF A01 CSCL 01C

Operational application of the command generator (CG) was examined in detail in a simulation of a flight control system with the augmentor wing jet STOL research aircraft. The basic repertoire of single axis maneuvers and operational constraints are discussed, and the system behavior is tested on a rigorous STOL approach path and as affected by various approximations in the CG synthesis and types of disturbances found in the operational environment. The simulation results indicate that a satisfactory nonlinear system with general maneuvering capabili-

ties throughout the flight envelope was developed which satisfies the basic design objectives while maintaining a practicable degree of simplicity.

Author

N78-14011#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**AIRFOIL DESIGN BY NUMERICAL OPTIMIZATION USING  
A MINICOMPUTER**

Raymond M. Hicks and C. A. Szczesak (Computer Information Systems, Cupertino, Calif.) Dec. 1979 28 p refs  
(NASA-TM-78502; A-7505) Avail: NTIS HC A03/MF A01  
CRCL 01A

A computer program developed for the automated design of low speed airfoils utilizes a generalized Joukowski method for aerodynamic analysis coupled with a conjugate gradient, penalty function, numerical optimization algorithm to give an efficient calculation technique for use with minicomputers. The program designs airfoils with a prescribed pressure distribution as well as those which minimize or maximize some aerodynamic force coefficient. At present the method is restricted to inviscid, incompressible flow. A typical design problem will execute in 4.5 hr on an HP 9830 minicomputer. A.R.H.

N78-14022#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**VORTEX EFFECTS FOR CANARD-WING CONFIGURATIONS  
AT HIGH ANGLES OF ATTACK IN SUBSONIC FLOW**

B. M. E. deSilva and R. T. Medan Dec. 1978 32 p refs  
(NASA-TM-78543; A-7677) Avail: NTIS HC A03/MF A01  
CSCL 01A

A fully three-dimensional subsonic panel method that can handle arbitrary shed vortex wakes is used to compute the nonlinear forces and moments on simple canard-wing configurations. The lifting surfaces and wakes are represented by doublet panels. The Mangler-Smith theory is used to provide an initial estimate for the vortex sheet shed from the leading edge. The trailing-edge wake and the leading-edge wake downstream of the trailing edge are assumed to be straight and leave the trailing edge at an angle of  $\alpha/2$ . Results indicate good agreement with experimental data up to 40 degs angle of attack. Author

N78-14024#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**EFFECTS OF UPPER SURFACE MODIFICATION ON THE  
AERODYNAMIC CHARACTERISTICS OF THE NACA 63  
SUB 2-215 AIRFOIL SECTION**

Raymond M. Hicks and Edward T. Schairer Jan. 1979 27 p refs

(NASA-TM-78503; A-7507) Avail: NTIS HC A03/MF A01  
CSCL 01A

An upper surface modification designed to increase the maximum lift coefficient of a 63 sub 2-215 airfoil section was tested at Mach numbers of 0.2, 0.3, and 0.4 Reynolds numbers of  $1.3 \times 10^6$ ,  $2 \times 10^6$  and  $2.5 \times 10^6$ . Comparisons of the aerodynamic coefficients before and after the modification were made. The upper surface modification increased the maximum lift coefficient of the airfoil significantly at all conditions. G.G.

N78-14082#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffet Field, Calif.

**EFFECTS OF VISUAL AND MOTION SIMULATION CUEING  
SYSTEMS ON PILOT PERFORMANCE DURING TAKEOFFS  
WITH ENGINE FAILURES**

Benton L. Parris and Anthony M. Cook Dec. 1978 85 p refs  
(NASA-TP-1165; A-7352) Avail: NTIS HC A06/MF A01 CSCL  
05H

Data are presented that show the effects of visual and motion during cueing on pilot performance during takeoffs with engine failures. Four groups of USAF pilots flew a simulated KC-135 using four different cueing systems. The most basic of these systems was of the instrument-only type. Visual scene simulation and/or motion simulation was added to produce the other systems. Learning curves, mean performance, and subjective data are examined. The results show that the addition of visual cueing results in significant improvement in pilot performance, but the combined use of visual and motion cueing results in far better performance.

Author

N78-14330\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**BI-DIRECTIONAL BURIED-WIRE SKIN-FRICTION GAGE**  
Hiroshi Higuchi (Dyn. Technol., Inc.) and David J. Peake Nov. 1978 27 p refs  
(NASA-TM-78531; A-7637) Avail: NTIS HC A03/MF A01 CSCL 20D

A compact, nonobtrusive, bi-directional, skin-friction gage was developed to measure the mean shear stress beneath a three-dimensional boundary layer. The gage works by measuring the heat flux from two orthogonal wires embedded in the surface. Such a gage was constructed and its characteristics were determined for different angles of yaw in a calibration experiment in subsonic flow with a Preston tube used as a standard. Sample gages were then used in a fully three-dimensional turbulent boundary layer on a circular cone at high relative incidence, where there were regimes of favorable and adverse pressure gradients and three-dimensional separation. Both the direction and magnitude of skin friction were then obtained on the cone surface.

Author

F N78-15064\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**NEW NASA-AMES WIND-TUNNEL TECHNIQUES FOR STUDYING AIRPLANE SPIN AND TWO-DIMENSIONAL UNSTEADY AERODYNAMICS**

Gerald N. Malcolm and Sanford S. Davis *In AGARD Dyn. Stability Parameters* Nov. 1978 12 p refs (For primary document see N79-15061 06-08)

Avail: NTIS HC A99/MF A01 CSCL 01C

Two new wind tunnel test apparatuses were developed at NASA-Ames Research Center. The first is a rotary-balance apparatus to be used in the Ames 12-Foot Pressure Tunnel for investigating the effects of Reynolds number, spin rate, and angle of attack on the aerodynamics of fighter and general aviation aircraft in a steady spin motion. The second apparatus provides capability for oscillating a large two-dimensional wing (0.5 m chord, 1.35 m span) instrumented with steady and unsteady pressure transducers in the Ames 11 x 11 ft. Transonic Wind Tunnel. A complete description of both apparatuses, their capabilities, and some typical wind tunnel results are presented.

G.Y.

N79-15814\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**A SAFETY MARGIN AND FLIGHT REFERENCE SYSTEM AND DISPLAY FOR POWERED-LIFT AIRCRAFT**

Robert K. Heffley and Gordon H. Hardy *In its The 14th Ann. Conf. on Manual Control* Nov. 1978 p 371-379 refs Prepared in cooperation with Systems Technol., Inc., Hawthorne, Calif. (For primary document see N79-15588 06-54)  
(Contract NAS2-9418)

Avail: NTIS HC A99/MF A01 CSCL 05H

A study was conducted to explore the feasibility of a safety margin and flight reference system for those powered-lift aircraft which require a backside piloting technique. The main objective was to display multiple safety margin criteria as a single variable which could be tracked both manually and automatically and which could be monitored in order to derive safety margin status.

The study involved a pilot-in-the-loop analysis of several system concepts and a simulator experiment to evaluate those concepts showing promise. A system was ultimately configured which yielded reasonable compromises in controllability, status information content, and the ability to regulate safety margins at some expense of the allowable low speed flight path envelope. G.Y.

N79-16785\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**COST AND SCHEDULE MANAGEMENT ON THE QUIET SHORT-HAUL RESEARCH AIRCRAFT PROJECT**

Darrell E. Wilcox and Peter Patterakis Jan. 1979 20 p refs (NASA-TM-78547; A-7684) Avail: NTIS HC A02/MF A01 CSCL 02A

The Quiet Short-Haul Research Aircraft (QSRA) Project, one of the largest aeronautical programs undertaken by NASA to date, achieved a significant cost underrun. This is attributed to numerous factors, not the least of which were the contractual arrangement and the system of cost and schedule management employed by the contractor. This paper summarizes that system and the methods used for cost/performance measurement by the contractor and by the NASA project management. Recommendations are made for the use of some of these concepts in particular for future programs of a similar nature.

Author

N79-17796\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AERODYNAMIC PROPERTIES OF A FLAT PLATE WITH CAVITY FOR OPTICAL-PROPAGATION STUDIES**

Donald A. Buell Jan. 1979 100 p refs (NASA-TM-78487; A-7450) Avail: NTIS HC A05/MF A01 CSCL 01A

Transonic wind-tunnel tests were performed on a flat plate with and without a cube-shaped cavity and antiresonance devices. Measurements were made of the optical propagation and aerodynamic properties of the boundary and shear layers. The model and its velocity profiles and pressures are described.

S.E.S.

N79-17804\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**WIND-TUNNEL INVESTIGATION OF THE THRUST AUGMENTOR PERFORMANCE OF A LARGE-SCALE SWEEP WING MODEL**

David G. Koenig and Michael D. Falarski (Army Aviation Res. and Develop. Command, St. Louis, Mo.) Feb. 1979 58 p refs (NASA-TM-X-73239; AVRACOM-TR-78-55(AM)) Avail: NTIS HC A04/MF A01 CSCL 01A

Tests were made in the Ames 40- by 80-foot wind tunnel to determine the forward speed effects on wing-mounted thrust augmentors. The large-scale model was powered by the compressor output of J-85 driven viper compressors. The flap settings used were 15 deg and 30 deg with 0 deg, 15 deg, and 30 deg aileron settings. The maximum duct pressure, and wind tunnel dynamic pressure were 66 cmHg (26 in Hg) and 1190 N/sq m (25 lb/sq ft), respectively. All tests were made at zero sideslip. Test results are presented without analysis.

J.M.S.

N79-17842\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**A STUDY OF REDUNDANCY MANAGEMENT STRATEGY FOR TETRAD STRAP-DOWN INERTIAL SYSTEMS**

Ronald J. Hruby, William S. Bjorkman (Analytical Mechanics Associates), Stanley F. Schmidt (Analytical Mechanics Associates), and Ralph A. Caresta (Southern Colorado Univ.) Feb. 1979 51 p refs (NASA-TM-78576; A-6725) Avail: NTIS HC A04/MF A01 CSCL 17G

Algorithms were developed that attempt to identify which sensor in a tetrad configuration has experienced a step failure. An algorithm is also described that provides a measure of the confidence with which the correct identification was made. Experimental results are presented from real-time tests conducted on a three-axis motion facility utilizing an ortho-skew tetrad strapdown inertial sensor package. The effects of prediction errors and of quantization on correct failure identification are discussed as well as an algorithm for detecting second failures through prediction.

A.R.H.

N79-17872#/ National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**CONFIGURATION MANAGEMENT AND AUTOMATIC CONTROL OF AN AUGMENTOR WING AIRCRAFT WITH VECTORED THRUST**

Luigi S. Cicolani, B. Sridhar, and George Meyer Mar. 1978 138 p refs  
(NASA-TP-1222; A-7099) Avail: NTIS HC A07/MF A01 CSCL 01C

An advanced structure for automatic flight control logic for powered-lift aircraft operating in terminal areas is under investigation at Ames Research Center. This structure is based on acceleration control; acceleration commands are constructed as the sum of acceleration on the reference trajectory and a corrective feedback acceleration to regulate path tracking errors. The central element of the structure, termed a Trimmap, uses a model of the aircraft aerodynamic and engine forces to calculate the control settings required to generate the acceleration commands. This report describes the design criteria for the Trimmap and derives a Trimmap for Ames experimental augmentor wing jet STOL research aircraft.

Author

N79-18815#/ National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**APPROXIMATION CONCEPTS FOR NUMERICAL AIRFOIL OPTIMIZATION**

Garret N. Vanderplaet Mar. 1979 38 p refs  
(NASA-TP-1370; A-7682) Avail: NTIS HC A03/MF A01 CSCL 01A

An efficient algorithm for airfoil optimization is presented. The algorithm utilizes approximation concepts to reduce the number of aerodynamic analyses required to reach the optimum design. Examples are presented and compared with previous results. Optimization efficiency improvements of more than a factor of 2 are demonstrated. Improvements in efficiency are demonstrated when analysis data obtained in previous designs are utilized. The method is a general optimization procedure and is not limited to this application. The method is intended for application to a wide range of engineering design problems.

S.E.S.

N79-18816#/ National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**INERTIAL DYNAMICS OF A GENERAL PURPOSE ROTOR**

Ronald W. DuVal Mar. 1979 34 p refs  
(NASA-TM-78557; A-7731) Avail: NTIS HC A03/MF A01 CSCL 01A

The inertial dynamics of a fully articulated stiff rotor blade are derived with emphasis on equations that facilitate an organized programming approach for simulation applications. The model for the derivation includes hinge offset and six degrees of freedom for the rotor shaft. Results are compared with the flapping and lead-lag equations currently used in the Rotor Systems Research Aircraft simulation model and differences are analyzed.

Author

N79-18860#/ National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**EVALUATION OF A WAKE VORTEX UPSET MODEL BASED**

**ON SIMULTANEOUS MEASUREMENTS OF WAKE VELOCITIES AND PROBE-AIRCRAFT ACCELERATIONS**  
Barbara J. Short and Robert A. Jacobson Mar. 1979 42 p refs  
(NASA-TM-78561; A-7735) Avail: NTIS HC A03/MF A01 CSCL 01C

Simultaneous measurements were made of the upset responses experienced and the wake velocities encountered by an instrumented Learjet probe aircraft behind a Boeing 747 vortex-generating aircraft. The vortex-induced angular accelerations experienced could be predicted within 30% by a mathematical upset response model when the characteristics of the wake were well represented by the vortex model. The vortex model used in the present study adequately represented the wake flow field when the vortices dissipated symmetrically and only one vortex pair existed in the wake.

L.S.

N79-19869#/ National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**HOLOGRAPHY AND LDV TECHNIQUES, THEIR STATUS**

**AND USE IN AIRFOIL RESEARCH**

D. A. Johnson and W. D. Bachalo (Spectron Development Inc.) /n NASA, Langley Res. Center Advanced Technol. Airfoil Res., Vol. 1, Pt. 2 1978 p 589-599 refs (For primary document see N79-19869 11-01)

Avail: NTIS HC A14/MF A01 CSCL 14E

The measurement capabilities of laser velocimetry and holographic interferometry in transonic airfoil testing were demonstrated. Presented are representative results obtained with these two nonintrusive techniques on a 15.24 cm chord airfoil section. These results include the density field about the airfoil, flow angles in the inviscid flow and viscous flow properties including the turbulent Reynolds stresses. The accuracies of the density fields obtained by interferometry were verified from comparisons with surface pressure and laser velocimeter measurements.

L.S.

F

N79-20004#/ National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**A NEW TWO-DIMENSIONAL OSCILLATING WING APPARATUS FOR UNSTEADY AERODYNAMICS RESEARCH**

Sanford S. Davis and Gerald N. Malcolm /n NASA, Langley Res. Center Advanced Technol. Airfoil Res., Vol. 1, Pt. 2 1978 p 671-688 refs (For primary document see N79-19869 11-01)  
Avail: NTIS HC A14/MF A01 CSCL 14B

An apparatus for experimental research into unsteady transonic flows is described. The apparatus, as installed in the NASA-Ames 11 by 11 Foot Transonic Wind Tunnel, can impart full two-degree-of-freedom motions at reduced frequencies to 0.3, oscillatory amplitudes to  $\pm 2$  degs, mean angles to 12 degs, Mach numbers to 1.4 and Reynolds numbers to  $12 \times 10^6$ . The test wing is fully instrumented for dynamic waveform measurements and the data can be acquired, processed, and displayed in real-time with a new computational data acquisition system. Following a description of the apparatus, sample data from a recently completed test program is presented.

L.S.

N79-20033#/ National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**OVERVIEW OF TWO-DIMENSIONAL AIRFOIL RESEARCH AT AMES RESEARCH CENTER**

Gary T. Chapman /n NASA, Langley Res. C Advanced Technol. Airfoil Res., Vol. 1, Pt. 1 1979 p 3-44 ref (For primary document see N79-20030 11-02)  
Avail: NTIS HC A20/MF A01 CSCL 01A

The five basic elements of the two dimensional airfoil research program at Ames Research Center are illustrated. These elements are experimental, theoretic (including computational), validation, design optimization, and interaction. Each area is briefly discussed.

J.M.S.

N79-20044# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**OPTIMIZATION OF MULTI-ELEMENT AIRFOILS FOR MAXIMUM LIFT**

Lawrence E. Olsen *In* NASA. Langley Res. Center Advanced Technol. Airfoil Res., Vol. 1, Pt. 1 1979 p 237-253 refs (For primary document see N79-20030 11-02)  
Avail: NTIS HC A20/MF A01 CSCL 01A

Two theoretical methods are presented for optimizing multi-element airfoils to obtain maximum lift. The analyses assume that the shapes of the various high lift elements are fixed. The objective of the design procedures is then to determine the optimum location and/or deflection of the leading and trailing edge devices. The first analysis determines the optimum horizontal and vertical location and the deflection of a leading edge slot. The structure of the flow field is calculated by iteratively coupling potential flow and boundary layer analysis. This design procedure does not require that flow separation effects be modeled. The second analysis determines the slot and flap deflection required to maximize the lift of a three element airfoil. This approach requires that the effects of flow separation from one or more of the airfoil elements be taken into account. The theoretical results are in good agreement with results of a wind tunnel test used to corroborate the predicted maximum slot and flap positions.

J.M.S.

N79-20049# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**APPLICATION OF NUMERICAL OPTIMIZATION TO THE DESIGN OF ADVANCED SUPERCRITICAL AIRFOILS**

Raymond R. Johnson (Vought Corp.) and Raymond M. Hicks *In* NASA. Langley Res. Center Advanced Technol. Airfoil Res., Vol. 1, Pt. 1 1979 p 315-325 refs (For primary document see N79-20030 11-02)

Avail: NTIS HC A20/MF A01 CSCL 01A

An application of numerical optimization to the design of advanced airfoils for transonic aircraft showed that low-drag sections can be developed for a given design Mach number without an accompanying drag increase at lower Mach numbers. This is achieved by imposing a constraint on the drag coefficient at an off-design Mach number while minimizing the drag coefficient at the design Mach number. This multiple design-point numerical optimization has been implemented with the use of airfoil shape functions which permit a wide range of attainable profiles during the optimization process. Analytical data for the starting airfoil shape, a single design-point optimized shape, and a double design-point optimized shape are presented. Experimental data obtained in the NASA Ames two-by two-foot wind tunnel are also presented and discussed.

L.S.

F

N79-20111# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**SURVEY OF HELICOPTER CONTROL/DISPLAY INVESTIGATIONS FOR INSTRUMENT DECELERATING APPROACH**

J. Victor Lebacqz Mar. 1979 133 p refs (NASA-TM-78565, A-7751) Avail: NTIS HC A07/MF A01 CSCL 01D

Control-display requirements for helicopters conducting decelerating approaches in the terminal area under instrument meteorological conditions were surveyed. The programs are organized on the basis of the control augmentation concepts that were considered, and the results are summarized and compared. Nine control-display combinations are hypothesized as possible candidates for future ground and in-flight investigation. Specific guidelines for the guidance relationship, control characteristics, and display presentation concepts are given.

S.F.S.

N79-22011# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**SYMMETRICAL AND ASYMMETRICAL SEPARATIONS ABOUT A YAWED CONE**

c02

David J. Peake, F. Kevin Owen (Owen Intern., Inc., Palo Alto,

Calif.), and Hiroshi Higuchi (Dyn. Technol., Inc., Torrance, Calif.) *In* AGARD High Angle of Attack Aerodyn. Jan. 1979 27 p refs (For primary document see N79-21996 13-01)  
(Contract NAS2-9863)

Avail: NTIS HC A23/MF A01 CSCL 01A

Three-dimensional flow separations about a 5 degree (semiangle angle, theta sub C), 1.4 m long, circular cone up to moderately high relative incidence, alpha/theta sub C approximately 5, were studied in the Mach number range 0.3 < M sub infinity < 1.8. The cone was tested in the Ames 1.8 by 1.8 m wind tunnel at Reynolds numbers, R sub L infinity, based on the cone length, L, from 4.5 times 10 to the 6th power to 13.5 times 10 to the 6th power, under nominally zero heat transfer conditions. Overall forces and mean surface pressures were compared with earlier measurements. Supportive three-dimensional laser velocimeter measurements of mean and fluctuating velocity in a slightly asymmetric vortex wake about a slender tangent ogive cylinder at incidence having respective nose and overall body fineness ratios of 3.5 and 12, are included.

G.Y.

N79-22023# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**PREDICTION OF AERODYNAMIC CHARACTERISTICS FOR SLENDER BODIES ALONE AND WITH LIFTING SURFACES TO HIGH ANGLES OF ATTACK**

c02

Leland H. Jorgensen *In* AGARD High Angle of Attack Aerodyn. Jan. 1979 40 p refs (For primary document see N79-21996 13-01)

Avail: NTIS HC A23/MF A01 CSCL 01A

A method is presented for computing normal force and pitching moment coefficients for slender bodies of circular and noncircular cross section alone and with lifting surfaces. A semiempirical term representing viscous-separation crossflow is added to a term representing potential-theory crossflow. For bodies of revolution, computed aerodynamic characteristics agree with measured results for investigated free-stream Mach numbers from 0.6 to 2.9 and for angles of attack from 0 deg to 180 deg. For bodies of elliptic cross section, measured results are predicted well over the investigated Mach number range from 0.6 to 2.0 and the angle range from 0 deg to 60 deg. For all bodies the predictions are best at supersonic Mach numbers. For body-wing and body-wing-tail configurations, measured normal force coefficients and centers are predicted at the upper test Mach number of 2.0. As the Mach number is decreased to 0.6, the agreement for the normal force coefficients rapidly deteriorates. When model flow-separation and vortex patterns are asymmetric, undesirable side forces are usually measured on the models at subsonic Mach numbers and zero sideslip angle. Generally, the side-force coefficients decrease or vanish with increase in Mach number, decrease in nose fineness ratio, nose blunting, and flattening of body cross section.

M.M.

N79-22026# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**HIGH ANGLE OF INCIDENCE IMPLICATIONS UPON AIR INTAKE DESIGN AND LOCATION FOR SUPERSONIC CRUISE AIRCRAFT AND HIGHLY MANEUVERABLE TRANSONIC AIRCRAFT**

c05

Leroy L. Presley *In* AGARD High Angle of Attack Aerodyn. Jan. 1979 10 p refs (For primary document see N79-21996 13-01)

Avail: NTIS HC A23/MF A01 CSCL 01C

The effects of angle of attack on supersonic mixed compression inlet performance at four different locations about a hypothetical forebody are given. A computational method to predict optimum inlet location, orientation, and centerbody control schedule for design and off-design performance is described. The effects of inlet location and a forward canard on the angle-of-attack performance of a normal shock inlet at transonic speeds were studied. Proper integration of inlet location and a forward canard can enhance the angle-of-attack performance of a normal shock inlet. Two lower lip treatments for improving the angle-of-attack performance of rectangular inlets at transonic speeds are discussed.

M.M.

N79-22035# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.  
**LOW-SPEED WIND-TUNNEL INVESTIGATION OF A  
LARGE-SCALE VTOL LIFT-FAN TRANSPORT MODEL**  
Kiyoshi Aoyagi Apr. 1979 72 p refs  
(NASA-TM-78560: A-7734) Avail: NTIS HC A04/MF A01  
CSCL 01A

An investigation was conducted in the NASA-Ames 40 by 80 Foot Wind Tunnel to determine the aerodynamic characteristics of a large scale, VTOL lift fan, jet transport model. The model had two lift fans at the forward portion of the fuselage, a lift fan at each wing tip, and two lift/cruise fans at the aft portion of the fuselage. All fans were driven by tip turbines using T-58 gas generators. Results were obtained for several lift fan, exit vane deflections and lift/cruise fan thrust deflections are zero sideslip. Three component longitudinal data are presented at several fan tip speed ratios. A limited amount of six component data were obtained with asymmetric vane settings. All of the data were obtained without a horizontal tail. Downwash angles at a typical tail location are also presented. Author

N79-23008# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.  
**COMPUTER FORMULATIONS OF AIRCRAFT MODELS FOR  
SIMULATION STUDIES**  
James C. Howard May 1979 73 p refs  
(NASA-TP-1470: A-7477) Avail: NTIS HC A04/MF A01 CSCL 02A

Recent developments in formula manipulation compilers and the design of several symbol manipulation languages, enable computers to be used for symbolic mathematical computation. A computer system and language that can be used to perform symbolic manipulations in an interactive mode are used to formulate a mathematical model of an aeronautical system. The example demonstrates that once the procedure is established, the formulation and modification of models for simulation studies can be reduced to a series of routine computer operations. J.M.S.

N79-23009# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.  
**A PILOTED SIMULATOR STUDY ON AUGMENTATION  
SYSTEMS TO IMPROVE HELICOPTER FLYING QUALITIES  
IN TERRAIN FLIGHT**  
Robert T. N. Chen, Peter D. Talbot, Ronald M. Gerdes, and  
Daniel C. Dugan Mar. 1979 57 p  
(NASA-TM-78571: A-7769) Avail: NTIS HC A04/MF A01  
CSCL 01C

Four basic single-rotor helicopters, one teetering, one articulated, and two hingeless, which were found to have a variety of major deficiencies in a previous fixed-based simulator study, were selected as baseline configurations. The stability and control augmentation systems (SCAS) include simple control augmentation systems to decouple pitch and yaw responses due to collective input and to quicken the pitch and roll control responses; SCAS of rate-command type designed to optimize the sensitivity and damping and to decouple the pitch-roll due to aircraft angular rate, and attitude-command type SCAS. Pilot ratings and commentary are presented as well as performance data related to the task. SCAS control usages and their gain levels associated with specific rotor types are also discussed. L.S.

N79-23022# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.  
**AN INVESTIGATION OF A FULL-SCALE ROTOR WITH FOUR  
BLADE TIP PLANFORM SHAPES**  
Robert H. Stroub May 1979 72 p refs Sponsored in part  
by AVRACOM  
(NASA-TM-78580: AVRACOM-TR-79-14: A-7793) Avail:  
NTIS HC A04/MF A01 CSCL 01A

A test of a full-scale helicopter rotor was conducted in the Ames Research Center 40- by 80-Foot Wind Tunnel to

investigate performance loads and noise characteristics of rotors with various tip geometries. Four blade tip geometries were investigated: rectangular, trapezoidal, swept rectangular, and swept trapezoidal. The investigation was accomplished over an advance-ratio range of 0.2 to 0.375 and an advancing blade Mach number range of 0.72 to 0.97. The performance aspects are presented with power comparisons between tip shapes. On a power basis, the best overall tip shape was the swept-trapezoidal geometry. J.M.S.

N79-23977# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.  
**A SIMPLIFIED ROTOR SYSTEM MATHEMATICAL MODEL  
FOR PILOTED FLIGHT DYNAMICS SIMULATION**  
Robert T. N. Chen May 1979 28 p refs  
(NASA-TM-78575: A-7538) Avail: NTIS HC A03/MF A01  
CSCL 01C

The model was developed for real-time pilot-in-the-loop investigation of helicopter flying qualities. The mathematical model included the tip-path plane dynamics and several primary rotor design parameters, such as flapping hinge restraint, flapping hinge offset, blade lead number, and pitch-flap coupling. The model was used in several exploratory studies of the flying qualities of helicopters with a variety of rotor systems. The basic assumptions used and the major steps involved in the development of the set of equations listed are described. The equations consisted of the tip-path plane dynamic equation, the equations for the main rotor forces and moments, and the equation for control phasing required to achieve decoupling in pitch and roll due to cyclic inputs. S.E.S.

N79-25021# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.  
**INTERFERENCE EFFECTS OF AIRCRAFT COMPONENTS  
ON THE LOCAL BLADE ANGLE OF ATTACK OF A  
WING-MOUNTED PROPELLER**  
J. P. Mendoza Jun. 1979 43 p refs  
(NASA-TM-78587: A-7812) Avail: NTIS HC A03/MF A01  
CSCL 01C

The aerodynamic interference effects on a propeller operating in the presence of different wing-body-nacelle combinations was studied. The unsteady blade angle of attack variation with azimuth angle by varying the pitch and yaw of the nacelle was minimized. Results indicate for the particular configuration of interest the minimum blade angle of attack variation occurred with the nacelle pitched downward 4.5 deg and yawed inward 3.0 deg. S.E.S.

N79-26009# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.  
**FUEL-CONSERVATIVE GUIDANCE SYSTEM FOR POWERED-LIFT AIRCRAFT**  
Heinz Erzberger and John D. McLean Jun. 1979 18 p refs  
To be presented at the AIAA Guidance and Control Conf., Boulder,  
Colo., 6-7 Aug. 1979  
(NASA-TM-78595: A-7860) Avail: NTIS HC A02/MF A01  
CSCL 01C

A concept for automatic terminal area guidance, comprising two modes of operation, was developed and evaluated in flight tests. In the predictive mode, fuel efficient approach trajectories are synthesized in fast time. In the tracking mode, the synthesized trajectories are reconstructed and tracked automatically. An energy rate performance model derived from the lift, drag, and propulsion system characteristics of the aircraft is used in the synthesis algorithm. The method optimizes the trajectory for the initial aircraft position and wind and temperature profiles encountered during each landing approach. The design theory and the results of simulations and flight tests using the Augmentor Wing Jet STOL Research Aircraft are described. S.E.S.

N78-26014# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**CONTROL OF FOREBODY THREE-DIMENSIONAL FLOW SEPARATIONS**

David J. Peake and F. Kevin Owen (Owen Intern., Inc., Palo Alto, Calif.) May 1979 52 p refs Presented at the AGARD Fluid Dyn. Panel Symp. on Aerodyn. Characteristics of Controls, Naples, May 1979 Sponsored in part by AFAL (Contract NAS2-9663)

(NASA-TM-78593; A-7841) Avail: NTIS HC A04/MF A01 CSCL 01A

Some experiments involving the development of the turbulent symmetric vortex flow about the lee side of a 5 deg semiangle conical forebody at high relative incidence are discussed. The cone was immersed in a Mach 0.6 airstream at a Reynolds number of 13.5 million based on the 1.4 - m axial length of the cone. Novel means of controlling the degree of asymmetry using blowing very close to the nose were investigated. Small amounts of air injected normally or tangentially to the cone surface, but on one side of the leeward meridian and beneath the vortex farthest from the wall, were effective in biasing the asymmetry. With this reorientation of the forebody vortices, the amplitude of the side force could be reduced to the point where its direction was reversed. This phenomenon could be obtained either by changing the blowing rate at constant incidence or by changing incidence at constant blowing rate. Normal injection was more effective than tangential injection. An organized and stable flow structure emerged with the jet vortices positioned above the forebody vortices. M.M.M.

N78-26017# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**WIND-TUNNEL INVESTIGATION OF HIGHLY MANEUVERABLE SUPERSONIC V/STOL FIGHTER**

Michael Falarski Jun. 1979 24 p refs Presented at V/STOL Aerodyn. Workshop, Monterey, Calif., May 1979

(NASA-TM-78599; A-787C) Avail: NTIS HC A02/MF A01 CSCL 01A

Results from the initial wind-tunnel test of a large-scale, highly maneuverable supersonic V/STOL fighter model in the Ames 40- by 80-foot wind tunnel are summarized. The STOL configuration which was tested combined upper surface blowing and spanwise blowing to improve the lift characteristics over a wide angle-of-attack range. A close-coupled canard was added to this configuration to create a highly maneuverable STOL aircraft. The 7.28 m (24 ft) span model was powered by two J-97 turbojet engines, each producing 9340 N (2200 lb) thrust at a pressure ratio of 2. With the nozzle flap and aileron set at 30 deg, the model produced lift coefficients greater than 4. The model was longitudinally unstable because of the forward canard position and because of the large body area of fuselage, strake, and nacelles forward of the center of gravity. J.A.M.

N78-26036# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**QUIET PROPULSIVE LIFT FOR COMMUTER AIRLINES**

Darrell E. Wilcox and John A. Cochrane Jun. 1979 29 p refs

(NASA-TM-78596; A-7861) Avail: NTIS HC A03/MF A01 CSCL 01C

The performance of STOL or RTOL aircraft and NASA's research program to provide options for future design and certification of quiet propulsive-lift transports is described. M.M.M.

N78-27100# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**LEADING-EDGE SLAT OPTIMIZATION FOR MAXIMUM AIRFOIL LIFT**

Lawrence E. Olson, Philip R. McGowan (Computer Sci. Corp., Mountain View, Calif.), and Clayton J. Guest (Computer Sci. Corp., Mountain View, Calif.) Jul. 1979 28 p refs

(NASA-TM-78566; A-7753) Avail: NTIS HC A03/MF A01 CSCL 01A

A numerical procedure for determining the position (horizontal location, vertical location, and deflection) of a leading edge slot that maximizes the lift of multielement airfoils is presented. The structure of the flow field is calculated by iteratively coupling potential flow and boundary layer analysis. This aerodynamic calculation is combined with a constrained function minimization analysis to determine the position of a leading edge slot so that the suction peak on the nose of the main airfoil is minimized. The slot position is constrained by the numerical procedure to ensure an attached boundary layer on the upper surface of the slot and to ensure negligible interaction between the slot wake and the boundary layer on the upper surface of the main airfoil. The highest angle attack at which this optimized slot position can maintain attached flow on the main airfoil defines the optimum slot position for maximum lift. The design method is demonstrated for an airfoil equipped with a leading-edge slot and a trailing edge, single-slotted flap. The theoretical results are compared with experimental data, obtained in the Ames 40 by 80 Foot Wind Tunnel, to verify experimentally the predicted slot position for maximum lift. The experimentally optimized slot position is in good agreement with the theoretical prediction, indicating that the theoretical procedure is a feasible design method. Author

N78-27130# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**AERODYNAMICS OF A TILT-NACELLE V/STOL PROPULSION SYSTEM**

Mark D. Betzina and Michael D. Falarski Jun. 1979 18 p refs Presented at Workshop of V/STOL Aerodynamics, Monterey, Calif., May 1979

(NASA-TM-78606; A-7849) Avail: NTIS HC A02/MF A01 CSCL 21E

Tests were performed in the Ames 40 by 80 Foot Wind Tunnel on a large-scale, tilt-nacelle V/STOL propulsion system to determine its aerodynamic characteristics. Unpowered nacelle aerodynamics and power induced effects over an angle of attack range from 0 to 105 deg are presented. It is shown that: (1) the characteristics of the unpowered nacelle can be estimated with annular airfoil data, (2) the power-induced effects on the nacelle aerodynamics are significant, and (3) pitching moment can be correlated with lift and thrust. S.E.S.

N78-27182# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**A COMPARISON OF THE V/STOL HANDLING QUALITIES OF THE VAK-191B WITH THE REQUIREMENTS OF AGARD REPORT 577 AND MIL-F-83300**

Seth B. Anderson Jul. 1979 38 p refs

(NASA-TP-1494; A-7117) Avail: NTIS HC A03/MF A01 CSCL 01C

The handling qualities of the VAK-191B VTOL aircraft are compared with current V/STOL handling qualities requirements. The aircraft handling qualities were superior to other V/STOL fighter aircraft. Several deficiencies which would seriously affect shipboard V/STOL operation includes: (1) poor hovering precision; (2) inadequate mechanical control characteristics; (3) nonlinear pitch and roll response; (4) an uncommanded movement of the height control lever; (5) low pitch control sensitivity; (6) excessive dihedral effect; and (7) inadequate overall thrust response. The attitude command control system resulted in reduced pilot workload during hover and low speed flight. S.E.S.

N78-27186# National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**EARTH WINDS, FLOW QUALITY, AND THE MINIMUM-PROTECTION INLET TREATMENT FOR THE NASA AMES 80- BY 120-FOOT WIND TUNNEL NONRETURN CIRCUIT**

William T. Eckart and Kenneth W. Mort Jun. 1979 20 p refs Prepared in cooperation with Army Aviation Res. and Dev. Command, Moffett Field, Calif.

(NASA-TM-78600; AVRACOM-TR-79-27; A-7877) Avail: NTIS HC A02/MF A01 CSCL 01E

The effect of the external wind on the quality of the flow in the test section was studied. The flow quality achievable with the complex treatment as well as that with the planned minimum treatment system is discussed. A scale model coupled with on site wind measurements demonstrated that the minimum treatment selected can provide adequate testing capabilities in the presence of the prevailing local winds, and that test programs will not be significantly affected by adverse wind effects on the test section flow quality. S.E.S.

N79-27439# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AN EXAMINATION OF A GROUP-VELOCITY CRITERION FOR THE BREAKDOWN OF AN IDEALIZED VORTEX FLOW**

Chon-Yin Tsai and Sheila E. Widnall (MIT, Cambridge) Jun. 1979 43 p refs

(NASA-TM-78541: A-7666) Avail: NTIS HC A03/MF A01 CSCL 20D

The phenomenon of vortex breakdown is believed to be associated with a finite amplitude wave that has become trapped at the critical or breakdown location. The conditions at which the propagating waves become trapped at a certain axial location were examined by use of a group-velocity criterion implied by Landahl's general theory of wave trapping. An ideal vortex having constant vorticity and uniform axial velocity at the inlet of a slowly diverging duct was studied. The linear wave propagation analysis is applied to the base flow at several axial stations for several values of the ratio of swirl velocity to axial velocity at the inlet of the divergent duct, assuming a locally parallel flow. The dispersion relations and hence the group velocities of both the symmetric ( $n = 0$ ) and asymmetric modes ( $n = +$  or  $- 1$ ) were investigated. The existence of a critical state in the flow (at which the group velocity vanishes), and its relationship to the stagnation point on the axis of the duct and to the occurrence of an irregular singularity in the equations governing wave propagation in the flow field are discussed. S.E.S.

N79-29144# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AERODYNAMIC CHARACTERISTICS OF A LARGE-SCALE SEMISPAN MODEL WITH A SWEEPED WING AND AN AUGMENTED JET FLAP WITH HYPERMIXING NOZZLES**

Thomas N. Aiken, Michael D. Falarski, and David G. Koenig Jul. 1979 87 p refs

(NASA-TM-73236: A-7013) Avail: NTIS HC A05/MF A01 CSCL 01A

The aerodynamic characteristics of the augmentor wing concept with hypermixing primary nozzles were investigated in a large-scale semispan model in the Ames 40- by 80-Foot Wind Tunnel and Static Test Facility was used. The trailing edge augmentor flap system occupied 65% of the span and consisted of two fixed pivot flaps. The nozzle system consisted of hypermixing lobes, primary nozzles, and BLC slot nozzles at the forward inlet, both sides and ends of the throat, and at the aft flap. The entire wing leading edge was fitted with a 10% chord slat and a blowing slot. Outboard of the flap was a blown aileron. The model was tested statically and at forward speed. Primary parameters and their ranges included angle of attack from -12 to 32 degrees, flap angles of 20, 30, 45, 60 and 70 degrees, and deflection and diffuser area ratios from 1.16 to 2.22. Thrust coefficients ranged from 0 to 2.73, while nozzle pressure ratios varied from 1.0 to 2.34. Reynolds number per foot varied from 0 to 14 million. Analysis of the data indicated a maximum static gross augmentation of 1.53 at a flap angle of 45 degrees. Analysis also indicated that the configuration was an efficient powered lift device and that the net thrust was comparable with augmentor wings of similar static performance. Performance at forward speed was best at a diffuser area ratio of 1.37. K.L.

N79-29489# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**A GROUP-VELOCITY CRITERION FOR BREAKDOWN OF VORTEX FLOW: AN APPLICATION TO MEASURED INLET PROFILES**

Chon-Yin Tsai and Sheila E. Widnall (MIT, Cambridge, Mass.) Jul. 1979 39 p refs

(NASA-TM-78542: A-7668) Avail: NTIS HC A03/MF A01 CSCL 20D

Vortex flows exhibiting breakdown in a slightly divergent duct were measured. The slowly varying vortex flow field downstream of the entrance and upstream of the breakdown region is obtained numerically by using the inviscid quasi-cylindrical approximation. In these calculations, the Falor and Lebovich's experimental data were used as the starting conditions at the entrance of the duct. The group velocity of wave propagation for the axisymmetric mode ( $n = 0$ ) and the asymmetric modes ( $n = +$  or  $- 1$  and  $n = +$  or  $- 2$ ) are calculated for the entrance conditions. For the theoretically predicted slowly varying flow field downstream of the entrance, the wave characteristics of the  $n = 0$  and  $n = +$  or  $- 1$  modes are presented. It was concluded that the flows which subsequently undergo vortex breakdown are all predicted to be supercritical and stable to infinitesimal inviscid disturbances, including the axially symmetric as well as the nonsymmetric perturbations. M.M.M.

N79-30143# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**UPPER-SURFACE MODIFICATIONS FOR C SUB 1 MAX IMPROVEMENT OF SELECTED NASA 6-SERIES AIRFOILS**

C. A. Szelazek and Raymond M. Hicks Aug. 1979 79 p refs Prepared in cooperation with Computer Information Systems, Cupertino, Calif.

(NASA-TM-78603: A-7889) Avail: NTIS HC A05/MF A01 CSCL 01A

The thickness of the upper surface of 64 airfoils was increased from the leading edge to the position of maximum thickness. The modifications were generated using a numerical optimization routine coupled with an aerodynamic analysis code. The type of modification presented can be used for aircraft design or for the retrofit of current aircraft to improve the stall characteristics and climb performance. The coordinates of the modified airfoils are presented with plots of the forward 45% of the profiles and pressure distributions for both the modified and unmodified sections at an angle of attack of 14 degrees. K.L.

F

N79-31137# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THE PROMISE OF MULTICYCLIC CONTROL**

John L. McCloud, III Aug. 1979 86 p refs

(NASA-TM-78621: A-7955) Avail: NTIS HC A03/MF A01 CSCL 02A

Several types of rotors which employ multicyclic control are reviewed and compared. Their differences are highlighted and their potential advantages and disadvantages are discussed. The flow field these rotors must operate in is discussed, and it is shown that simultaneous elimination of vibration and oscillatory blade loads is not an inherent solution to the roughness problem. The use of rotor blades as energy absorbers is proposed. Input-output relations are considered and a gain control for RDMULAN, a multicyclic controlling computer program, is introduced. Implications of the introduction of multicyclic systems into helicopters are discussed. A.W.H.

N79-32205# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**LOW-COST INERTIAL NAVIGATION FOR MODERATE-G MISSIONS**

Shmuel Merhav Sep. 1979 61 p refs

(NASA-TM-78611: A-7920) Avail: NTIS HC A04/MF A01 CSCL 01D

A low cost inertial navigation system (INS) concept is described for flight missions characterized by moderate accelerations and limited attitude variations. These missions involve general aviation aircraft, helicopters, or remotely piloted vehicles. The significance of the moderate acceleration and limited attitude is reviewed with respect to platform mechanization and instrumentation. A hybrid mechanization, partially gimballed and partially strapdown, is presented. The INS is implemented by an unbalanced two axis gimbal system and controlled by a two degree of freedom gyro. The INS provides locally level two axis acceleration information along with pitch and roll measurements. Heading information is provided by a second gyro mounted in the inner gimbal. The system error model is equivalent to that of a conventional platform with a tilt error determined by the integral of the gyro drift rate and an equivalent accelerometer type errors are also cancelled. Rapid gyro-compassing, implemented with opened gimbal control loops, and a strapdown procedure provides calibration of gyro drift rate biases.

A.W.H.

remote multiplexer/demultiplexer unit, a Hewlett-Packard 9825A calculator, and a Bell and Howell airborne instrumentation tape recorder. The sensor data are recorded on the tape in a serial pulse code modulated format. The PCM tape is then converted in two steps to a magnetic tape that is FORTRAN compatible with the IBM-360 computer. This technical memorandum describes the system configuration, the sensor characteristics, and the format of the resulting data and serves as a system user's guide.

G.Y.

N79-33167#/ National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**WIND-TUNNEL INVESTIGATION OF A LARGE-SCALE VTOL AIRCRAFT MODEL WITH WING ROOT AND WING THRUST AUGMENTORS**

Kiyoshi Aoyagi and Thomas N. Aiken Sep. 1979 60 p refs (NASA-TM-78589; A-7823) Avail: NTIS HC A04/MF A01 CSCL 01A

Tests were conducted in the Ames 40 by 80 foot wind tunnel to determine the aerodynamic characteristics of a large-scale V/STOL aircraft model with thrust augmentors. The model had a double-delta wing of aspect ratio 1.65 with augmentors located in the wing root and the wing trailing edge. The supply air for the augmentor primary nozzles was provided by the YJ-97 turbojet engine. The airflow was apportioned approximately 74 percent to the wing root augmentor and 24 percent to wing augmentor. Results were obtained at several trailing-edge flap deflections with the nozzle jet-momentum coefficients ranging from 0 to 7.9. Three-component longitudinal data are presented with the augmentor operating with and without the horizontal tail. A limited amount of six component data are also presented.

Author

F

X79-10088#/ National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**COST ESTIMATION FOR RESEARCH AIRCRAFT PROJECTS**

Darrell E. Wilcox Feb. 1979 23 p refs (NASA-TM-78546; A-7680) Unclassified report

NOTICE Available to U.S. Government Agencies

Preliminary design cost estimates form the basis for budget determination, program approval, and subsequent performance measurement on research aircraft programs. Unrealistic estimates early in the program are the source of problems for many project managers forced to operate within budgets that understated the technical complexity of the job. A parametric cost model developed for use in estimating the cost of several research aircraft procured by NASA in the 1970's is described.

A.R.H.

X79-10106#/ National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**DATA ACQUISITION SYSTEM FOR THE NASA-AMES CESSNA 402B AIRCRAFT**

Betty K. Berkstresser, Leonard C. Hee, and Charles I. Jackson, Jr. May 1979 99 p refs (NASA-TM-78583; A-7806) Unclassified report

NOTICE Available to NASA and NASA Contractors

The NASA Cessna 402B aircraft was equipped with a data acquisition system. The system includes sensors, a Teledyne

X79-10107#/ National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**INSTRUMENTATION CALIBRATION MANUAL FOR UH-1H HELICOPTER WITH V/StOLAND SYSTEM**

John M. Davis Apr. 1979 167 p refs Prepared in cooperation with Army Aviation Res. and Develop. Command, Moffett Field, Calif.

(NASA-TM-78568; AVRADCOM-TR-79-21(AM); A-7759)

Unclassified report

NOTICE Available to NASA and NASA Contractors.

The data acquisition system for the UH-1H helicopter with the V/Stoland Flight Control System, which is stationed at Ames Research Center, Moffett Field, California is described. An overview of the system, general and specific procedures for calibrating the system, plus data from the July 1978 calibration are discussed. The information required to perform a complete calibration and to illustrate the results of one such calibration are presented.

M.M.

## NASA CONTRACTOR REPORTS

N79-10024#/ Northrop Corp., Hawthorne, Calif. Aircraft Group.

**STUDY OF AERODYNAMIC TECHNOLOGY FOR VSTOL FIGHTER/ATTACK AIRCRAFT: HORIZONTAL ATTITUDE CONCEPT Final Report**

S. H. Brown May 1978 242 p refs Sponsored in part by the David Taylor Naval Ship Research and Development Center, Bethesda, Md.

(Contract NAS2-9771)

(NASA-CR-152130; NOR78-54) Avail: NTIS HC A11/MF A01 CSCL 01A

A horizontal attitude VSTOL (HAVSTOL) supersonic fighter attack aircraft powered by RALS turbofan propulsion system is analyzed. Reaction control for subaerodynamic flight is obtained in pitch and yaw from the RALS and roll from wingtip jets powered by bleed air from the RALS duct. Emphasis is placed on the development of aerodynamic characteristics and the identification of aerodynamic uncertainties. A wind tunnel program is shown to resolve some of the uncertainties. Aerodynamic data developed are static characteristics about all axes, control effectiveness, drag, propulsion induced effects and reaction control characteristics.

G.Y.

X79-10C25#/ General Dynamics/Fort Worth, Tex.

**STUDY OF AERODYNAMIC TECHNOLOGY FOR VSTOL FIGHTER/ATTACK AIRCRAFT, VOLUME 1 Final Report, 1 Nov. 1977 - 31 May 1978**

J. R. Lummus May 1978 264 p refs Sponsored in part by the David Taylor Naval Ship Research and Development Center, Bethesda, Md.

(Contract NAS2-9769)

(NASA-CR-152128) Avail: NTIS HC A12/MF A01 CSCL 01A

An assessment was made of the aerodynamic uncertainties associated with the design of a cold-deck-environment Navy VSTOL fighter/attack aircraft utilizing jet-diffuser ejectors for

vertical lift and vectored-engine-over-wing blowing for supercirculation benefits. The critical aerodynamic uncertainties were determined as those associated with the constraints which size the aircraft to a specified set of requirements. A wind tunnel model and test programs are recommended for resolving these uncertainties.

G.G.

N78-10028# Northrop Corp., Hawthorne, Calif.

**STUDY OF AERODYNAMIC TECHNOLOGY FOR VSTOL FIGHTER/ATTACK AIRCRAFT: VERTICAL ATTITUDE CONCEPT** Final Report, 1 Nov. 1977 - 31 May 1978

H. A. Gerhardt and W. S. Chen May 1978 253 p refs Sponsored in part by the David Taylor Naval Ship Research and Development Center, Bethesda, Md.

(Contract NAS2-9771)

(NASA-CR-152131) Avail: NTIS HC A12/MF A01 CSCL 01A

The aerodynamic technology for a vertical attitude VSTOL (VATOL) supersonic fighter/attack aircraft was studied. The selected configuration features a tailless clipped delta wing with leading-edge extension (LEX), maneuvering flaps, top-side inlet, twin dry engines and vectoring nozzles. A relaxed static stability is employed in conjunction with the maneuvering flaps to optimize transonic performance and minimize supersonic trim drag. Control for subsaturation flight is obtained by gimballing the nozzles in combination with wing tip jets. Emphasis is placed on the development of aerodynamic characteristics and the identification of aerodynamic uncertainties. A wind tunnel test program is proposed to resolve these uncertainties and ascertain the feasibility of the conceptual design. Ship interface, flight control integration, crew station concepts, advanced weapons, avionics, and materials are discussed.

G.Y.

N78-10027# Grumman Aerospace Corp., Bethpage, N.Y.

**STUDY OF AERODYNAMIC TECHNOLOGY FOR VSTOL FIGHTER ATTACK AIRCRAFT** Final Report, 1 Nov. 1977 - 23 May, 1978

W. Burhans, Jr., Vincent J. Crafta, Jr., N. Dennenhofer, Frank A. Dellamura, and Robert E. Krepki 23 May 1978 196 p refs Sponsored in part by David Taylor Naval Ship Research and Development Center, Bethesda, Md.

(Contract NAS2-9770)

(NASA-CR-152129; POR-623-24) Avail: NTIS HC A09/MF A01 CSCL 01A

Vertical short takeoff aircraft capability, supersonic dash capability, and transonic agility were investigated for the development of fighter/attack aircraft to be accommodated on ships smaller than present aircraft carriers. Topics covered include: (1) description of viable V-STOL fighter/attack configuration (a high wing, close-coupled canard, twin-engine, control configured aircraft) which meets or exceeds specified levels of vehicle performance; (2) estimates of vehicle aerodynamic characteristics and the methodology utilized to generate them; (3) description of propulsion system characteristics and vehicle mass properties; (4) identification of areas of aerodynamic uncertainty; and (5) a test program to investigate the areas of aerodynamic uncertainty in the conventional flight mode.

A.R.H.

N78-10028# Vought Corp., Dallas, Tex.

**STUDY OF AERODYNAMIC TECHNOLOGY FOR VSTOL FIGHTER/ATTACK AIRCRAFT, PHASE 1** Final Report, Nov. 1977 - May 1978

Herbert H. Driggers May 1978 182 p refs Sponsored in part by David Taylor Naval Ship Research and Development Center, Bethesda, Md.

(Contract NAS2-9772)

(NASA-CR-152132; Rept-2-31200/8CR-79) Avail: NTIS HC A09/MF A01 CSCL 01A

A conceptual design study was performed of a vertical attitude takeoff and landing (VATOL) fighter/attack aircraft. The configuration has a close-coupled canard-delta wing, side two-dimensional ramp inlets, and two augmented turbofan engines with thrust vectoring capability. Performance and sensitivity to objective

requirements were calculated. Aerodynamic characteristics were estimated based on contractor and NASA wind tunnel data. Computer simulations of VATOL transitions were performed. Successful transitions can be made, even with series post-stall instabilities, if reaction controls are properly phased. Principal aerodynamic uncertainties identified were post-stall aerodynamics, transonic aerodynamics with thrust vectoring and inlet performance in VATOL transition. A wind tunnel research program was recommended to resolve the aerodynamic uncertainties. Author

N78-10038# Analytical Mechanics Associates, Inc., Mountain View, Calif.

**IMPLEMENTATION OF AN OPTIMUM PROFILE GUIDANCE SYSTEM ON STOLAND**

Paul F. Flanagan Sep. 1978 49 p refs

(Contract NAS2-9460)

(NASA-CR-152187) Avail: NTIS HC A03/MF A01 CSCL 17G

The implementation on the STOLAND airborne digital computer of an optimum profile guidance system for the augmentor wing jet STOL research aircraft is described. Major tasks were to implement the guidance and control logic to airborne computer software and to integrate the module with the existing STOLAND navigation, display, and autopilot routines. The optimum profile guidance system comprises an algorithm for synthesizing minimum fuel trajectories for a wide range of starting positions in the terminal area and a control law for flying the aircraft automatically along the trajectory. The avionics software developed is described along with a FORTRAN program that was constructed to reflect the modular nature and algorithms implemented in the avionics software.

J.M.S.

F

N78-12064# AVCON Aviation Consultants, Boulder, Colo.  
**OPERATIONAL REQUIREMENTS FOR FLIGHT CONTROL AND NAVIGATION SYSTEMS FOR SHORT HAUL TRANSPORT AIRCRAFT**

John A. Morrison May 1978 90 p

(Contract NAS2-9028)

(NASA-CR-152208) Avail: NTIS HC A05/MF A01 CSCL 17G

To provide a background for evaluating advanced STOL systems concepts, a number of short haul and STOL airline operations in the United States and one operation in Canada were studied. A study of flight director operational procedures for an advanced STOL research airplane, the Augmented Wing Jet STOL Research Airplane, was conducted using the STOLAND simulation facility located at the Ames Changes to the advanced digital flight control system (STOLAND) installed in the Augmentor Wing Airplane are proposed to improve the mode sequencing to simplify pilot procedures and reduce pilot workload.

S.B.S.

N78-12066# Systems Technology, Inc., Mountain View, Calif.  
**A STUDY OF KEY FEATURES OF THE RAE ATMOSPHERIC TURBULENCE MODEL**

Wayne F. Jewell and Robert K. Heffley Oct. 1978 84 p refs

(Contract NAS2-9942)

(NASA-CR-152194; STI-TR-1126-1) Avail: NTIS HC A05/MF A01 CSCL 04B

A complex atmospheric turbulence model for use in aircraft simulation is analyzed in terms of its temporal, spectral, and statistical characteristics. First, a direct comparison was made between cases of the RAE model and the more conventional Dryden turbulence model. Next the control parameters of the RAE model were systematically varied and the effects noted. The RAE model was found to possess a high degree of flexibility in its characteristics, but the individual control parameters are cross-coupled in terms of their effect on various measures of intensity, bandwidth, and probability distribution.

G.G.

N78-13001# Lockheed-Georgia Co., Marietta.  
**ANALYSIS OF A THEORETICALLY OPTIMIZED TRANSONIC AIRFOIL**  
M. E. Lorca, K. P. Burdges, and G. D. Shrewsbury Nov. 1978  
102 p refs  
(Contract NAS2-8897)  
(NASA-CR-3065: LG78ER0212) Avail: NTIS  
HC A06/MF A01 CSCL 01A

Numerical optimization was used in conjunction with an inviscid, full potential equation, transonic flow analysis computer code to design an upper surface contour for a conventional airfoil to improve its supercritical performance. The modified airfoil was tested in a compressible flow wind tunnel. The modified airfoil's performance was evaluated by comparison with test data for the baseline airfoil and for an airfoil developed by optimization of leading edge of the baseline airfoil. While the leading edge modification performed as expected, the upper surface re-design did not produce all of the expected performance improvements. Theoretical solutions computed using a full potential, transonic airfoil code corrected for viscosity were compared to experimental data for the baseline airfoil and the upper surface modification. These correlations showed that the theory predicted the aerodynamics of the baseline airfoil fairly well, but failed to accurately compute drag characteristics for the upper surface modification.

S.B.S.

N78-13004# Northrop Corp., Hawthorne, Calif. Aircraft Div.  
**INVESTIGATION OF STEADY AND FLUCTUATING PRESSURES ASSOCIATED WITH THE TRANSONIC BUFFETTING AND WING ROCK OF A ONE-SEVENTH SCALE MODEL OF THE F-5A AIRCRAFT** Final Report  
Chintsun Hwang and W. S. Pi Nov. 1978 213 p refs  
(Contract NAS2-8734)

(NASA-CR-3061) Avail: NTIS HC A10/MF A01 CSCL 01A  
A wind tunnel test of a 1/7 scale F-5A model is described. The pressure, force, and dynamic response measurements during buffet and wing rock are evaluated. Effects of Mach number, angle of attack, sideslip angle, and control surface settings were investigated. The mean and fluctuating static pressure data are presented and correlated with some corresponding flight test data of a F-5A aircraft. Details of the instrumentation and the specially designed support system which allowed the model to oscillate in roll to simulate wing rock are also described. A limit cycle mechanism causing wing rock was identified from this study, and this mechanism is presented.

G.Y.

F  
N78-13007# Nielsen Engineering and Research, Inc., Mountain View, Calif.  
**OPERATIONAL MANUAL FOR TWO-DIMENSIONAL TRANSONIC CODE TBF0IL** Final Report  
Stephen S. Stahara Dec. 1978 185 p refs  
(Contract NAS2-8648)  
(NASA-CR-3064: NEAR-TR-94) Avail: NTIS  
HC A09/MF A01 CSCL 01A

This code solves the two-dimensional, transonic, small-disturbance equations for flow past lifting airfoils in both free air and various wind-tunnel environments by using a variant of the finite-difference method. A description of the theoretical and numerical basis of the code is provided, together with complete operating instructions and sample cases for the general user. In addition, a programmer's manual is also presented to assist the user interested in modifying the code. Included in the programmer's manual are a dictionary of subroutine variables in common and a detailed description of each subroutine.

G.G.

N78-13047# Borst (Henry V.) and Associates, Wayne, Pa.  
**A NEW BLADE ELEMENT METHOD FOR CALCULATING THE PERFORMANCE OF HIGH AND INTERMEDIATE SOLIDITY AXIAL FLOW FANS**  
Henry V. Borst Nov. 1978 51 p refs  
(Contract NAS2-9079)

(NASA-CR-3063) Avail: NTIS HC A04/MF A01 CSCL 21E  
A method is presented to design and predict the performance of axial flow rotors operating in a duct. The same method is

suitable for the design of ducted fans and open propellers. The unified method is based on the blade element approach and the vortex theory for determining the three dimensional effects, so that two dimensional airfoil data can be used for determining the resultant force on each blade element. Resolution of this force in the thrust and torque planes and integration allows the total performance of the rotor, fan or propeller to be predicted. Three different methods of analysis, one based on a momentum flow theory; another on the vortex theory of propellers; and a third based on the theory of ducted fans, agree and reduce cascade airfoil data to single line as a function of the loading and induced angle of attack at values of constant inflow angle. The theory applies for any solidity from .01 to over 1 and any blade section camber. The effects of the duct and blade number can be determined so that the procedure applies over the entire range from two blade open propellers, to ducted helicopter tail rotors, to axial flow compressors with or without guide vanes, and to wind tunnel drive fans.

Author

N78-14020# General Dynamics/Fort Worth, Tex.  
**A METHOD FOR PREDICTING FULL SCALE BUFFET RESPONSE WITH RIGID WIND TUNNEL MODEL FLUCTUATING PRESSURE DATA. VOLUME 1: PREDICTION METHOD DEVELOPMENT AND ASSESSMENT**

Atlee M. Cunningham, Jr., David B. Benepe, Darlene Watts, and Paul G. Waner Nov. 1978 147 p refs  
(Contract NAS2-7091)

(NASA-CR-3035) Avail: NTIS HC A07/MF A01 CSCL 01A

The method requires unsteady aerodynamic forces, natural airplane modes, and the measured pressure data as input. A gust response computer program is used to calculate buffet response due to the forcing function posed by the measured pressure data. By calculating both symmetric and antisymmetric solutions, upper and lower bounds on full-scale buffet response are formed. Comparisons of predictions with flight test results are made and the effects of horizontal tail loads and static aeroelasticity are shown. Discussions are also presented on the effects of primary wing torsion modes, chordwise and spanwise phase angles, and altitude.

Author

N78-14021# General Dynamics/Fort Worth, Tex.  
**A METHOD FOR PREDICTING FULL SCALE BUFFET RESPONSE WITH RIGID WIND TUNNEL MODEL FLUCTUATING PRESSURE DATA. VOLUME 2: POWER SPECTRAL DENSITIES FOR METHOD ASSESSMENT**

Atlee M. Cunningham, Jr., David B. Benepe, Darlene Watts, and Paul G. Waner Nov. 1978 239 p  
(Contract NAS2-7091)

(NASA-CR-3036) Avail: NTIS HC A11/MF A01 CSCL 01A

The predicted upper and lower bounds power spectra for all of the cases and response items given in Volume 1 are plotted. The flight test power spectra are shown on each prediction plot for the nominal value of angle of attack that most closely agrees with the flexible angle for the prediction. The flight test and prediction conditions are given in tabular form for all cases considered.

F.O.S

N78-14114# Systems Technology, Inc., Mountain View, Calif.  
**PILOTED AIRCRAFT SIMULATION CONCEPTS AND OVERVIEW**

John B. Sinacori Mar. 1978 100 p refs  
(Contract NAS2-9024)

(NASA-CR-152200: STI-TR-1074-2) Avail: NTIS  
HC A05/MF A01 CSCL 01C

An overview of piloted aircraft simulation is presented that reflects the viewpoint of an aeronautical technologist. The intent is to acquaint potential users with some of the basic concepts and issues that characterize piloted simulation. Application to the development of aircraft are highlighted, but some aspects of training simulators are covered. A historical review is given together with a description of some current simulators. Simulator usages, advantages, and limitations are discussed and human perception qualities important to simulation are related. An assessment of current simulation is presented that addresses

validity, fidelity, and deficiencies. Future prospects are discussed and technology projections are made.

Author

N79-18551# Systems Control, Inc., Palo Alto, Calif.  
**HUMAN OPERATOR IDENTIFICATION MODEL AND RELATED COMPUTER PROGRAMS Final Report**  
K. M. Kessler and J. N. Mohr Dec. 1978 145 p  
(Contract NAS2-9754)  
(NASA-CR-152237) Avail: NTIS HC A07/MF A01 CSCL 05H

Four computer programs which provide computational assistance in the analysis of man/machine systems are reported. The programs are: (1) Modified Transfer Function Program (TF); (2) Time Varying Response Program (TVSR); (3) Optimal Simulation Program (TVOPT); and (4) Linear Identification Program (SCIDNT). The TV program converts the time domain state variable system representative to frequency domain transfer function system representation. The TVSR program computes time histories of the input/output responses of the human operator model. The TVOPT program is an optimal simulation program and is similar to TVSR in that it produces time histories of system states associated with an operator in the loop system. The differences between the two programs are presented. The SCIDNT program is an open loop identification code which operates on the simulated data from TVOPT (or TVSR) or real operator data from motion simulators. G.Y.

N79-17511# Computer Sciences Corp., Mountain View, Calif.  
**THE EFFECT OF A VISUAL/MOTION DISPLAY MISMATCH IN A SINGLE AXIS COMPENSATORY TRACKING TASK**

c53  
Douglas K. Shirachi and Richard S. Shirley /in MIT Proc., 13th Ann. Conf. on Manual Control 1977 p 361-376 refs (For primary document see N79-17475 08-51)  
(Contract NAS2-7806)  
Avail: NTIS HC A20/MF A01 CSCL 05J

The frequency response of visual systems is typically unity from 0 to 20 rad/sec, while that of motion systems typically falls off in the vicinity of 6 rad/sec. This question arises as to what effect, if any, such a difference in servomechanism performance has on the simulation. Is pilot performance reduced by the conflict between displays? Would a more realistic simulation occur if the visual servomechanisms were degraded to match the motion servomechanisms? Does the pilot need and use the higher frequency information present in the visual display? The purpose of the experiment is to take a step forward toward answering these questions. Work already in the literature which bears on these questions is outlined. A description is then given of an experiment used to check for the effects of a difference in the performance of the visual and motion servomechanisms (the experiment uses a single-axis, compensatory, roll-tracking task). The results of the experiment are then presented and analyzed.

L.S.

N79-17801# Lockheed-California Co., Burbank.  
**DELTA METHOD, AN EMPIRICAL DRAG BUILDUP TECHNIQUE Final Report, 1 Mar. - 31 Dec. 1978**  
Richard C. Feagin and William D. Morrison Dec. 1978 177 p refs  
(Contract NAS2-8612)  
(NASA-CR-151971; LR-27975-Vol-1) Avail: NTIS HC A09/MF A01 CSCL 01A

An empirical drag correlation technique was developed from analysis of 19 subsonic and supersonic military aircraft and 15 advanced or supercritical airfoil configurations which can be applied in conceptual and advanced aircraft design activities. The Delta Method may be used for estimating the clean wing drag polar for cruise and maneuver conditions up to buffet onset, and to approximately Mach 2.0. This technique incorporates a unique capability of predicting the off-design performance of advanced or supercritical airfoil sections. The buffet onset limit may also be estimated. The method is applicable to wind tunnel models as well as to full scale configurations. This technique has been converted into a computer code for use on the IBM 360 and CDC 7600 computer facilities at NASA AMES. Results

obtained using this method to predict known aircraft characteristics are good and agreement can be obtained within a degree of accuracy judged to be sufficient for the initial processes of preliminary design.

F.O.S.

N79-18973# University of Southern Illinois, Carbondale. Dept. of Electrical Sciences and Systems Engineering.

**GASP-PL/I SIMULATION OF INTEGRATED AVIONIC SYSTEM PROCESSOR ARCHITECTURES M.S. Thesis**

Glen A. Brent Sep. 1978 274 p refs  
(Grant NaG-2238)  
(NASA-CR-158244) Avail: NTIS HC A12/MF A01 CSCL 01D

A development study sponsored by NASA was completed in July 1977 which proposed a complete integration of all aircraft instrumentation into a single modular system. Instead of using the current single-function aircraft instruments, computers compiled and displayed inflight information for the pilot. A processor architecture called the Team Architecture was proposed. This is a hardware/software approach to high-reliability computer systems. A follow-up study of the proposed Team Architecture is reported. GASP-PL/I simulation models are used to evaluate the operating characteristics of the Team Architecture. The problem, model development, simulation programs and results at length are presented. Also included are program input formats, outputs and listings.

G.Y.

N79-20089# Stanford Univ., Calif. Joint Inst. for Aeronautics and Acoustics.

**FLAP-LAG-TORSION FLUTTER ANALYSIS OF A CONSTANT LIFE ROTOR**

Inderjit Chopra Jan. 1979 42 p  
(Grant NaG-2317)  
(NASA-CR-152244; SU-JIAA-TR-17) Avail: NTIS HC A03/MF A01 CSCL 01C

F

The constant lift rotor (CLR) employs a control input of pitch moment to several airfoil sections which are free to pivot on a continuous spar, allowing them to change their pitch to obtain the desired lift. A flap-lag-torsion flutter analysis of a constant lift rotor blade in hover was developed. The blade model assumes rigid body flap and lead-lag motions at the root hinge and each strip undergoes an independent torsional motion. The results are presented in terms of root locus plots of complex eigenvalues as a function of thrust. The effects of several parameters (including structural damping, center of gravity and elastic axis offset from aerodynamic center, compressibility pitch-lag and pitch-flap coupling) on the blade dynamics are examined. With a suitable combination of lag damper and pitch-flap coupling, it is possible to design a constant lift rotor blades free from flutter instability.

Author

N79-20140# Spectron Development Labs., Inc., Costa Mesa, Calif.

**FEASIBILITY STUDY OF TRANSIT PHOTON CORRELATION ANEMOMETER FOR AMES RESEARCH CENTER UNITARY WIND TUNNEL PLAN Final Report**

W. T. Mayo, Jr. and A. E. Smart 7 Feb. 1979 86 p refs  
Original contains color illustrations  
(Contract NAS2-10072)

(NASA-CR-152238; SDL-79-6397) Avail: NTIS HC A05/MF A01 CSCL 14B

A laser transit anemometer measured a two-dimensional vector velocity, using the transit time of scattering particles between two focused and parallel laser beams. The objectives were: (1) the determination of the concentration levels and light scattering efficiencies of naturally occurring, submicron particles in the NASA Ames unitary wind tunnel and (2) the evaluation based on these measured data of a laser transit anemometer with digital correlation processing for nonintrusive velocity measurement in this facility. The evaluation criteria were the speeds at which point velocity measurements could be realized with this technique (as determined from computer simulations) for given accuracy requirements.

J.A.M.

N79-20309\*/# Brown Univ., Providence, R. I. Lefschetz Center for Dynamical Systems.

**APPLICATIONS OF ALGEBRAIC GEOMETRY IN SYSTEM THEORY** Interim Report

Peter L. Falb (Harvard Univ., Cambridge, Mass.) and Christopher I. Byrnes Oct. 1978 43 p refs  
(Grant NsG-2265; Contract N00014-75 C 0548; Grant AF-AFOSR-1516-78)  
(NASA-CR-158408; AD-A062770; AFOSR-78-1514TP) Avail: NTIS HC A03/MF A01 CSCL 12A

System theory is concerned with the modelling and analysis of phenomena both natural and man-made. It is a discipline whose formal beginnings go back at least to Watt and Maxwell and much of its motivation stems from engineering problems. Before World War II, a system design and analysis were primarily an art. During and after the war techniques based on complex variable theory were developed and applied primarily to single input, single output systems represented by a rational function, called the transfer function. The theory of servomechanisms developed rapidly from the end of the war to the early fifties and time-domain methods were applied. The representation of transfer functions via linear, constant-coefficient, differential equations led to a renewed interest in so-called state space methods. The rapid development of the theory followed and continues today. However, the increasing complexity of the engineering and economic problems considered required greater mathematical sophistication.

G.R.A.

N79-22048\*/# TRW Defense and Space Systems Group, Redondo Beach, Calif.

**EVALUATION OF THE DISCRETE VORTEX WAKE CROSS FLOW MODEL USING VECTOR COMPUTERS. PART 1: THEORY AND APPLICATION**

Jan. 1979 102 p refs 2 Vol.  
(Contract NAS2-9579)  
(NASA-CR-152270; TRW-30584-6001-RU-00-Pt-1) Avail: NTIS HC A06/MF A01 CSCL 01A

The current program had the objective to modify a discrete vortex wake method to efficiently compute the aerodynamic forces and moments on high fineness ratio bodies (approximately 10.0). The approach is to increase computational efficiency by structuring the program to take advantage of new computer vector software and by developing new algorithms when vector software can not efficiently be used. An efficient program was written and substantial savings achieved. Several test cases were run for fineness ratios up to  $f = 16.0$  and angles of attack up to 50 degrees.

G.Y.

N79-22049\*/# TRW Defense and Space Systems Group, Redondo Beach, Calif.

**EVALUATION OF THE DISCRETE VORTEX WAKE CROSS FLOW MODEL USING VECTOR COMPUTERS. PART 2: USER'S MANUAL FOR DIVORCE**

F. D. Deffenbaugh and J. F. Vitz Jan. 1979 70 p refs 2 Vol.  
(Contract NAS2-9579)  
(NASA-CR-152271; TRW-30584-6002-RU-00-Pt-2) Avail: NTIS HC A04/MF A01 CSCL 01A

The users manual for the Discrete Vortex Cross flow Evaluator (DIVORCE) computer program is presented. DIVORCE was developed in FORTRAN 4 for the DDC 6800 and CDC 7600 machines. Optimal calls to a NASA vector subroutine package are provided for use with the CDC 7600.

G.Y.

N79-22062\*/# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

**AN ANALYSIS OF LONG AND MEDIUM-HAUL AIR PASSENGER DEMAND, VOLUME 1** Final Report

Steven E. Eriksen 1978 75 p refs  
(Grant NsG-2129)  
(NASA-CR-152156) Avail: NTIS HC A04/MF A01 CSCL 05C

A basic model was developed which is a two equation pair

of econometric system in which air passenger demand and airline level-of-service are the endogenous variables. The model aims to identify the relationship between each of these two variables and its determining factors, and to identify the interaction of demand and level-of-service with each other. The selected variable for the measure of air passenger traffic activity in a given pair market is defined as the number of passengers in a given time that originate in one region and fly to the other region for purposes other than to make a connection to a third region. For medium and long haul markets, the model seems to perform better for larger markets. This is due to a specification problem regarding the route structure variable. In larger markets, a greater percentage of nonlocal passengers are accounted for by this variable. Comparing the estimated fare elasticities of long and medium haul markets, it appears that air transportation demand is more price elastic in longer haul markets. Long haul markets demand will saturate with a fewer number of departures than will demand in medium haul markets.

A.R.H.

N79-22063\*/# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

**AN ANALYSIS OF SHORT HAUL AIR PASSENGER DEMAND, VOLUME 2** Final Report

Terry P. Blumer and William M. Swan 1978 132 p refs  
(Grant NsG-2129)  
(NASA-CR-152157) Avail: NTIS HC A07/MF A01 CSCL 05C

Several demand models for short haul air travel are proposed and calibrated on pooled data. The models are designed to predict demand and analyze some of the motivating phenomena behind demand generation. In particular, an attempt is made to include the effects of competing modes and of alternate destinations. The results support three conclusions: (1) the auto mode is the air mode's major competitor; (2) trip time is an overriding factor in intermodal competition, with air fare at its present level appearing unimportant to the typical short haul air traveler; and (3) distance appears to underly several demand generating phenomena and therefore, must be considered very carefully to any intercity demand model. It may be the cause of the wide range of fare elasticities reported by researchers over the past 15 years. A behavioral demand model is proposed and calibrated. It combines the travel generating effects of income and population, the effects of modal split, the sensitivity of travel to price and time, and the effect of alternative destinations satisfying the trip purpose.

A.R.H.

N79-22064\*/# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

**AN ECONOMIC MODEL OF THE MANUFACTURERS' AIRCRAFT PRODUCTION AND AIRLINE EARNINGS POTENTIAL, VOLUME 3** Final Report

James T. Kneafsey and Richard M. Hill 1978 185 p refs  
(Grant NsG-2129)  
(NASA-CR-152158) Avail: NTIS HC A09/MF A01 CSCL 05C

A behavioral explanation of the process of technological change in the U. S. aircraft manufacturing and airline industries is presented. The model indicates the principal factors which influence the aircraft (airframe) manufacturers in researching, developing, constructing and promoting new aircraft technology; and the financial requirements which determine the delivery of new aircraft to the domestic trunk airlines. Following specification and calibration of the model, the types and numbers of new aircraft were estimated historically for each airline's fleet. Examples of possible applications of the model to forecasting an individual airline's future fleet also are provided. The functional form of the model is a composite which was derived from several preceding econometric models developed on the foundations of the economics of innovation, acquisition, and technological change and represents an important contribution to the improved understanding of the economic and financial requirements for aircraft selection and production. The model's primary application will be to forecast the future types and numbers of new aircraft required for each domestic airline's fleet.

A.R.H.

N78-22366# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

**THE IMPACT OF CHANGING TECHNOLOGY ON THE DEMAND FOR AIR TRANSPORTATION Final Report**

James T. Kneafsey and Nawal K. Taneja 1978 27 p refs

(Grant NAG-2129)

(NASA-CR-152191) Avail: NTIS HC A03/MF A01 CSCL 05C

Demand models for air transportation that are sensitive to the impact of changing technology were developed. The models are responsive to potential changes in technology, and to changing economic, social, and political factors as well. In addition to anticipating the wide differences in the factors influencing the demand for long haul and short haul air travel, the models were designed to clearly distinguish among the unique features of these markets.

J.M.S.

To quantify the installed performance of high speed ( $M = 0.8$ ) turboprop propulsion systems, an experimental program designed to assess the magnitude of the aerodynamic interference of a propeller slipstream on a supercritical wing has been conducted. The test was conducted in the NASA Ames 14-foot wind tunnel. An ejector-nacelle propeller slipstream simulator was used to produce a slipstream with characteristics typical of advanced propellers presently being investigated. A supercritical wing-body configuration was used to evaluate the interference effects. A traversing total pressure rake was used to make flow field measurements behind the wing and to calibrate the slipstream simulator. The force results indicated that the interference drag amounted to an increase of ten counts or about 3% of the wing-body drag for a two engine configuration at the nominal propeller operating conditions. However, at the higher swirl angles (11 deg vs. 7 deg nominally) the interference drag was favorable by about the same magnitude.

Author

N78-22070# Boeing Vertol Co., Philadelphia, Pa.

**IDENTIFICATION OF HIGH PAYOFF RESEARCH FOR MORE EFFICIENT APPLICATOR HELICOPTERS IN AGRICULTURE AND FORESTRY**

Kenneth T. Waters May 1979 84 p refs

(Contract NAS2-10040)

(NASA-CR-152258: D210-11193-1) Avail: NTIS HC A06/MF A01 CSCL 01C

The results of a study of the uses of helicopters in agriculture and forestry in the United States are discussed. Comparisons with agricultural airplanes are made in terms of costs of aerial application to the growers. An analysis of cost drivers and potential improvements to helicopters that will lower costs is presented. Future trends are discussed, and recommendations for research are outlined. Operational safety hazards and accident records are examined, and problem areas are identified. Areas where research and development are needed to provide opportunities for lowering costs while increasing productivity are analyzed.

Author

N78-22100# Flow Research, Inc., Kent, Wash.

**PROCEDURE FOR NOISE PREDICTION AND OPTIMIZATION OF ADVANCED TECHNOLOGY PROPELLERS Final Report**

Wen-Huei Jou and Samuel Bernstein Apr. 1979 54 p refs

(Contract NAS2-9807)

(NASA-CR-3080: Rept-119) Avail: NTIS HC A04/MF A01 CSCL 01C

The sound field due to a propeller operating at supersonic tip speed in a uniform flow was investigated. Using the fact that the wave front in a uniform stream is a convected sphere, the fundamental solution to the convected wave equation was easily obtained. The Fourier coefficients of the pressure signature were obtained by a far field approximation, and are expressed as an integral over the blade platform. It is shown that cones of silence exist fore and aft the propeller plane. The semiaxes angles are shown. These angles are independent of the individual Mach components such as the flight Mach number and the rotation Mach number. The result is confirmed by the computation of the ray path of the emitted Mach waves. The Doppler amplification factor strengthens the signal behind the propeller while it weakens that upstream.

J.M.S.

F

N78-25024# Douglas Aircraft Co., Inc., Long Beach, Calif.  
**SIMULATED PROPELLER SLIPSTREAM EFFECTS ON A SUPERCRITICAL WING**

H. Robert Welge and James P. Crowder Jun. 1978 72 p refs

(Contract NAS2-9472)

(NASA-CR-152138) Avail: NTIS HC A04/MF A01 CSCL 21E

N78-26056# McDonnell Aircraft Co., St. Louis, Mo.

**THRUST AND MASS FLOW CHARACTERISTICS OF FOUR 36 INCH DIAMETER TIP TURBINE FAN THRUST VECTORING SYSTEMS IN AND OUT OF GROUND EFFECT**

D. W. Esker and H. A. Roddiger Jun. 1979 105 p refs

(Contract NAS2-9690)

(NASA-CR-152239: MDC-A5704) Avail: NTIS HC A06/MF A01 CSCL 21E

The calibration tests carried out on the propulsion system components of a 70 percent scale, powered model of a NASA 3-fan V/STOL aircraft configuration are described. The three X3/6B/T58 turboprop fan units used in the large scale powered model were tested on an isolated basis over a range of ground heights from  $H/D = 1.02$  to infinity. A higher pressure ratio LF336/J85 fan unit was tested over a range of ground heights from 1.55 to infinity. The results of the test program demonstrated that: (1) the thrust and mass flow performance of the X376B/T58 nose lift unit is essentially constant for  $H/D$  variations down to 1.55; at  $H/D = 1.02$  back pressurization of the fan exit occurs and is accompanied by an increase in thrust of five percent; (2) a change in nose fan exit hub shape from flat plate to hemispherical produces no significant difference in louvered lift nozzle performance for height variations from  $H/D = 1.02$  to infinity; (3) operation of the nose lift nozzle at the higher fan pressure ratio generated by the LF336/J85 fan system causes no significant change in ground proximity performance down to an  $H/D$  of 1.55, the lowest height tested with this unit; and (4) the performance of the left and right X376B/T58 lift/cruise units in the vertical lift mode remains unchanged, within plus or minus two percent for the range of ground heights from  $H/D = 1.02$  to infinity.

J.M.S.

N79-26062\*# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.

**A WIND-TUNNEL INVESTIGATION OF TILT-ROTOR GUST ALLEVIATION SYSTEMS** Final Report, 1972 - 1978

Norman D. Ham and H. Philip Whitaker Jan. 1978 140 p refs  
(Contract NAS2-7262)

(NASA-CR-152284: ASRL-TR-174-7) Avail: NTIS

HC A07/MF A01 CSCL 01C

The alleviation of the effects of gusts on tilt rotor aircraft by means of active control systems was investigated. The gust generator, the derivation of the equations of motion of the rotor wing combination, the correlation of these equations with the results of wind tunnel model tests, the use of the equations to design various gust alleviating active control systems, and the testing and evaluation of these control systems by means of wind tunnel model tests were developed. S.E.S.

N79-26374\*# Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.

**INVESTIGATION OF A LASER DOPPLER VELOCIMETER SYSTEM TO MEASURE THE FLOW FIELD AROUND A LARGE SCALE V/STOL AIRCRAFT IN GROUND EFFECT**

Andrew D. Zalay, Melvin R. Brashears, Archie J. Jordan, Kenneth R. Shrider, and Carl D. Vought May 1979 76 p refs Document includes a microfiche supplement  
(Contract NAS2-8959)

(NASA-CR-152212; LMSC-HREC-TR-D568) Avail: NTIS HC E04/MF A01 CSCL 14B

The flow field measured around a hovering 70 percent scale vertical takeoff and landing (V/STOL) aircraft model is described. The velocity measurements were conducted with a ground based laser Doppler velocimeter. The remote sensing instrumentation and experimental tests of the velocity surveys are discussed. The distribution of vertical velocity in the fan jet and fountain; the radial velocity in the wall jet and the horizontal velocity along the aircraft underside are presented for different engine rpms and aircraft height above ground. Results show that it is feasible to use a mobile laser Doppler velocimeter to measure the flow field generated by a large scale V/STOL aircraft operating in ground effect. S.E.S.

F

N79-27126\*# Princeton Univ., N. J. Dept. of Mechanical and Aerospace Engineering.

**THE INFLUENCE OF FEEDBACK ON THE AEROELASTIC BEHAVIOR OF TILT PROPTOROTOR AIRCRAFT INCLUDING THE EFFECTS OF FUSELAGE MOTION** Final Technical Report, 1 Sep. 1978 - 31 Jan. 1979

H. C. Curtiss, Jr., T. Komatsuzaki, and J. J. Traybar Jul. 1979 178 p refs  
(Grant NsG-2181)

(NASA-CR-158778; TR-1441) Avail: NTIS HC A09/MF A01 CSCL 01C

The influence of single loop feedbacks to improve the stability of the system are considered. Reduced order dynamic models are employed where appropriate to promote physical insight. The influence of fuselage freedom on the aeroelastic stability, and the influence of the airframe flexibility on the low frequency modes of motion relevant to the stability and control characteristics of the vehicle were examined. S.E.S.

N79-28141\*# Rockwell International Corp., Columbus, Ohio. LOW SPEED WIND TUNNEL TEST OF GROUND PROXIMITY AND DECK EDGE EFFECTS ON A LIFT CRUISE FAN V/STOL CONFIGURATION, VOLUME 1 Contractor Report, Mar. 1978 - Feb. 1979

V. R. Stewart May 1979 118 p  
(Contract NAS2-9882)

(NASA-CR-152247: NR79H-12-Vol-1) Avail: NTIS HC A06/MF A01 CSCL 01A

The characteristics were determined of a lift cruise fan V/STOL

multi-mission configuration in the near proximity to the edge of a small flat surface representation of a ship deck. Tests were conducted at both static and forward speed test conditions. The model (0.12 scale) tested was a four fan configuration with modifications to represent a three fan configuration. Analysis of data showed that the deck edge effects were in general less critical in terms of differences from free air than a full deck (in ground effect) configuration. The one exception to this was when the aft edge of the deck was located under the center of gravity. This condition, representative of an approach from the rear, showed a significant lift loss. Induced moments were generally small compared to the single axis control power requirements, but will likely add to the pilot work load. R.E.S.

N79-28142\*# Rockwell International Corp., Columbus, Ohio. LOW SPEED WIND TUNNEL TEST OF GROUND PROXIMITY AND DECK EDGE EFFECTS ON A LIFT CRUISE FAN V/STOL CONFIGURATION, VOLUME 2 Contractor Report, Mar. 1978 - Feb. 1979

V. R. Stewart May 1979 484 p

(Contract NAS2-1882)

(NASA-CR-152248: NR79H-12-Vol-2) Avail: NTIS HC A21/MF A01 CSCL 01A

The following test results are appended: (1) wind tunnel data, (2) static thrust stand data, and (3) fan calibration data.

R.E.S.

N79-28884\*# Massachusetts Inst. of Tech., Cambridge. Fluid Dynamics Research Lab.

**EXPERIMENTAL AND THEORETICAL STUDIES ON MODEL HELICOPTER ROTOR NOISE** Interim Rep't, Mar. 1976 - Dec. 1977

Krishnaswamy S. Aravamudan and Wesley L. Harris Jan. 1978 158 p refs Submitted for publication

(Grant NsG-2095; Contract DAAG29-76-C-0027)

(NASA-CR-158844; AD-A068180; ARO-12931.2-EX;

Rept-83852-1; Rept-7B-1) Avail: NTIS HC A08/MF A01 CSCL 20/1

A simplified Mach number scaling law is obtained for rotational and broadband noise components of a model helicopter rotor. The broadband noise sources are further classified into low frequency and high frequency components. The scaling laws are based on the geometric and performance parameters of the rotor and characteristics of the flow field. The existing theory of Lowson and Ollerhead is used deriving the conventional sixth power law for the rotational noise of geometrically similar blades operating in similar flow environments. The knowledge of unsteady aerodynamics was exploited to yield analytical formulation for the low frequency broadband radiation. The ambiguous state of the art regarding the origin and nature of high frequency broadband noise does not permit such a straightforward scaling law for this frequency regime. Vortices are assumed to be shed at unknown Strouhal frequency and the scaling law is derived by simply integrating the blade sectional velocity over the span. The MIT 5 x 7-1/2 foot anechoic wind tunnel was used to perform experiments at controlled flow environ. Turbulence was generated at the inlet of the tunnel and simultaneous measurements of acoustic and turbulence signals were made. The experimentally obtained results are compared with the computed intensities and spectra of rotational noise, low frequency broadband noise and high frequency broadband noise from model rotors. GRA

N79-29196\*# Princeton Univ., N. J. Flight Research Lab. AN IN-FLIGHT SIMULATOR INVESTIGATION OF ROLL AND YAW CONTROL POWER REQUIREMENTS FOR STOL APPROACH AND LANDING: DEVELOPMENT OF CAPABILITY AND PRELIMINARY RESULTS

D. R. Ellis and S. C. Raisingshani Apr. 1979 44 p refs  
(Contract NAS2-7350)

(NASA-CR-152307: MAE-1422) Avail: NTIS HC A03/MF A01 CSCL 01C

A six-degree-of-freedom variable-response research aircraft was used to determine the minimum lateral-directional control power required for desirable and acceptable levels of handling qualities for the STOL landing approach task in a variety of simulated atmospheric disturbance conditions for a range of lateral-directional response characteristics. Topics covered include the in-flight simulator, crosswind simulation, turbulence simulation, test configurations, and evaluation procedures. Conclusions based on a limited sampling of simulated STOL transport configurations flown to touchdown out of 6 deg. 75 kt MLS approaches, usually with a sidestep maneuver are discussed.

A.R.H

N79-30138\*# Rail Co., Baltimore, Md.  
**MAINTENANCE COST STUDY OF ROTARY WING AIRCRAFT, PHASE 2 Interim Report**  
Aug. 1979 34 p  
(Contract NAS2-9143)  
(NASA-CR-152291) Avail: NTIS HC A03/MF A01 CSCL 02A

The Navy's maintenance and materials management data base was used in a study to determine the feasibility of predicting unscheduled maintenance costs for the dynamic systems of military rotary wing aircraft. The major operational and design variables were identified and the direct maintenance man hours per flight hour were obtained by step-wise multiple regression analysis. Five nonmilitary helicopter users were contacted to supply data on which variables were important factors in civil applications. These uses included offshore oil exploration and support, police and fire department rescue and enforcement, logging and heavy equipment movement, and U.S. Army military operations. The equations developed were highly effective in predicting unscheduled direct maintenance man hours per flying hours for military aircraft, but less effective for commercial or public service helicopters, probably because of the longer mission durations and the much higher utilization of civil users.

A.R.H

N79-30144\*# Analytical Methods, Inc., Bellevue, Wash.  
**UNSTEADY FLOW MODEL FOR CIRCULATION-CONTROL AIRFOILS**  
Balusu M. Rao Jun. 1979 28 p refs  
(Contract NAS2-10132)  
(NASA-CR-152301) Avail: NTIS HC A03/MF A01 CSCL 01A

An analysis and a numerical lifting surface method are developed for predicting the unsteady airloads on two-dimensional circulation control airfoils in incompressible flow. The analysis and the computer program are validated by correlating the computed unsteady airloads with test data and also with other theoretical solutions. Additionally, a mathematical model for predicting the bending-torsion flutter of a two-dimensional airfoil (a reference section of a wing or rotor blade) and a computer program using an iterative scheme are developed. The flutter program has a provision for using the CC airfoil airloads program or the Theodorsen hard flap solution to compute the unsteady lift and moment used in the flutter equations. The adopted mathematical model and the iterative scheme are used to perform a flutter analysis of a typical CC rotor blade reference section. The program seems to work well within the basic assumption of the incompressible flow.

Author

N79-30193\*# Massachusetts Inst. of Tech., Cambridge. Lab. for Information and Decision Systems.  
**VTOL CONTROLS FOR SHIPBOARD LANDING**  
M.S. Thesis  
Christopher Graham McMuldron Aug. 1979 198 p refs  
(Contract NGL-22-009-124)  
(NASA-CR-162140; LIDS-TH-928) Avail: NTIS HC A09/MF A01 CSCL 01C

The problem of landing a VTOL aircraft on a small ship in rough seas using an automatic controller is examined. The controller design uses the linear quadratic Gaussian results of modern control theory. Linear time invariant dynamic models are developed for the aircraft, ship, and wave motions. A hover controller commands the aircraft to track position and orientation of the ship deck using only low levels of control power. Commands for this task are generated by the solution of the steady state linear quadratic gaussian regulator problem. Analytical performance and control requirement tradeoffs are obtained. A landing controller commands the aircraft from stationary hover along a smooth, low control effort trajectory, to a touchdown on a predicted crest of ship motion. The design problem is formulated and solved as an approximate finite-time linear quadratic stochastic regulator. Performance and control results are found by Monte Carlo simulations.

K.L

N79-31195\*# Lockheed-Georgia Co., Marietta.  
**CORRELATION OF DATA RELATED TO SHOCK-INDUCED TRAILING-EDGE SEPARATION AND EXTRAPOLATION TO FLIGHT REYNOLDS NUMBER**  
J. F. Cahill and P. C. Connor Washington NASA Sep. 1979 82 p refs  
(Contract NAS2-9331)

(NASA-CR-3178) Avail: NTIS HC A05/MF A01 CSCL 01C  
Pressure data from a number of previous wind tunnel and flight investigations of high speed transport type wings were analyzed with the intent of developing a procedure for extrapolating low Reynolds number data to flight conditions. These analyses produced a correlation of the development of trailing-edge separation resulting from increases in Mach number and/or angle of attack and show that scale effects on this correlated separation development and the resulting shock location changes fall into a regular and apparently universal pattern. Further studies appear warranted to refine the correlation through a detailed consideration of boundary layer characteristics, and to evaluate scale effects on supercritical wings.

Author

F

N79-31222\*# Systems Technology, Inc., Mountain View, Calif.  
**A COMPILATION AND ANALYSIS OF HELICOPTER HANDLING QUALITIES DATA. VOLUME 2: DATA ANALYSIS**

Robert K. Heffley Aug. 1979 176 p refs  
(Contract NAS2-9344)  
(NASA-CR-3145; TR-1087-2-Vol-2) Avail: NTIS HC A09/MF A01 CSCL 01C

A compilation and an analysis of helicopter handling qualities data are presented. Multiloop manual control methods are used to analyze the descriptive data, stability derivatives, and transfer functions for a six degrees of freedom, quasi static model. A compensatory loop structure is applied to coupled longitudinal, lateral and directional equations in such a way that key handling qualities features are examined directly.

A.W.H

N79-32219\*# Lockheed-Georgia Co., Marietta.  
**ESTIMATION OF TUNNEL BLOCKAGE FROM WALL PRESSURE SIGNATURES: A REVIEW AND DATA CORRELATION**

J. E. Hackett, D. J. Wilsden, and D. E. Lilley Mar. 1979 170 p refs  
(Contract NAS2-9883)  
(NASA-CR-152241) Avail: NTIS HC A08/MF A01 CSCL 14B

A method is described for estimating low speed wind tunnel blockage, including model volume, bubble separation and viscous wake effects. A tunnel-centerline, source/sink distribution is derived from measured wall pressure signatures using fast algorithms to solve the inverse problem in three dimensions. Blockage may then be computed throughout the test volume. Correlations using scaled models or tests in two tunnels were made in all cases. In many cases model reference area exceeded 10% of the tunnel cross-sectional area. Good correlations were obtained regarding model surface pressures, lift drag and pitching moment. It is shown that blockage-induced velocity variation:

across the test section are relatively unimportant but axis gradients should be considered when model size is determined.

M.M.M

**X79-10005# Boeing Commercial Airplane Co., Seattle, Wash.  
AN ANALYSIS OF PROP-FAN/AIRFRAME AERODYNAMIC  
INTEGRATION Final Report**

M. L. Boctor, C. W. Clay, and C. F. Watson Oct. 1978 78 p refs

(Contract NAS2-9104)

(NASA-CR-152186; D6-47113)

Unclassified report

NOTICE: Available to U.S. Government Agencies and Their Contractors.

Potential flow analytical techniques were used to study aerodynamic integration of the prop-fan propulsion concept with advanced, subsonic, commercial transport airframes. Three basic configurations were defined and analyzed. (1) wing-mounted prop-fan at a cruise Mach number of 0.8, (2) wing-mounted prop-fan in a low-speed configuration, and (3) aft-mounted prop-fan at a cruise Mach number of 0.8.

S.B.S

**X79-10018# RAND Corp., Santa Monica, Calif.  
PREDICTING COST/RELIABILITY/MAINTAINABILITY OF  
ADVANCED GENERAL AVIONICS EQUIPMENT**

M. R. Davis, M. Kamins, and W. E. Mooz Jun. 1978 130 p refs

(Contract NAS2-9450)

(NASA-CR-152149; RAND/WN-10233-NASA)

Unclassified report

NOTICE: Available to U.S. Government Agencies and Their Contractors.

Practical problems experienced by industry and user groups in predicting the cost, reliability, and maintainability of avionics for general air-aviation aircraft are reviewed. The advantages and limitation of different modeling approaches for cost and reliability estimates are discussed as well as the special problems caused by the lack of historical data on maintenance costs. Suggestions are offered on how NASA might proceed in assessing these factors in the absence of reliable generalized predictive models.

A.R.H.

**X79-10021# Computer Sciences Corp., El Segundo, Calif.  
ELECTRONIC FOG GENERATOR FOR FLIGHT  
SIMULATION**

Elmer E. Moots and Marny Chase Jul. 1978 25 p

(Contract NAS2-9741)

(NASA-CR-152265)

Unclassified report

NOTICE: Available to U.S. Government Agencies and Their Contractors.

At NASA/Ames Research Center, a color television monitor is located at the windshield of a flight simulator to present the pilot's visual flight display. A Fog Generator blends an electronically generated high-altitude blue sky, fog, haze, or cloud representation with the pilot's visual display. The result is a reliable, repeatable, computer-controlled visual scene, which adds to the realism of simulated flight.

L.S

**X79-10101# Systems Technology, Inc., Hawthorne, Calif.  
SIMULATION MODEL OF CESSNA 402-B Final Report,  
Sep. 1977 - Jul. 1978**  
Roger H. Hoh, David G. Mitchell, and Thomas T. Myers Jul.  
1979 138 p refs  
(Contract NAS2-9735)  
(NASA-CR-152176; TR-1112-1)

Unclassified report

NOTICE: Available to U.S. Government Agencies and Their Contractors.

A simulation model for the NASA Cessna 402B was developed. The aerodynamic data were generated by adjusting full scale wind tunnel data from a similar configuration (Cessna 310) using analytical and empirical techniques. Lift and drag estimates were adjusted based on performance data obtained from flight test. Asymmetric thrust effects were not modeled. The engine model was based on data obtained from the manufacturer and flight test measurements. The longitudinal control system model included the bobweight and downspring effects, as well as coulomb friction. Aileron and rudder friction and breakout forces were also included in the model. The Cessna 400B Navomatic autopilot was given in simulation block diagram form.

J.A.M.

## **JOURNAL ARTICLES, BOOKS AND CHAPTERS OF BOOKS**

**A79-10398\*** Simulation study of the effect of fuel-conservative approaches on ATC procedures and terminal area capacity. L. Tobias, E. A. Palmer (NASA, Ames Research Center, Moffett Field, Calif.), and P. J. O'Brien (FAA, National Aviation Facilities Experimental Center, Atlantic City, N.J.). *Society of Automotive Engineers, Air Transportation Meeting, Boston, Mass., May 1-4, 1978, Paper 780523.* 13 p. 6 refs.

Fuel-conservative procedures have been investigated using real-time air traffic control simulations linked to two piloted simulators. The fuel-conservative procedures studied were profile descents and two types of landing approaches. The investigation determined the effect of these procedures on the ATC system and terminal area capacity. It examined the mixing of aircraft executing fuel-conservative approaches with those executing conventional approaches. The results indicate a systems fuel savings for the landing approaches under all tested conditions except at, or near, maximum system capacity. Also, there is a fuel savings and reduced controller workload for the profile descent procedures.

(Author)

**A79-10903\*** Conference on Helicopter Structures Technology, Moffett Field, Calif., November 13-18, 1977, Proceedings. Conference sponsored by the American Helicopter Society and NASA, Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 211 p. \$10.00. (For individual items see A79-10904 to A79-10921)

Work on advanced concepts for helicopter designs is reported. Emphasis is on use of advanced composites, damage-tolerant design, and load calculations. Topics covered include structural design flight maneuver loads using PDP-10 flight dynamics model, use of 3D finite element analysis in design of helicopter mechanical components, damage-tolerant design of the YUH-61A main rotor system, survivability of helicopters to rotor blade ballistic damage, Development of a multitubular spar composite main rotor blade, and a bearingless main rotor structural design approach using advanced composites.

H.

A79-10905 # Structural design flight maneuver loads using PDP-10 flight dynamics model. E. C. McLaud, K. C. Hansen, and W. J. Jackson, Jr. In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 13 p.

In order to achieve more accurate predicted applied loads and inertial reactions during structural design, a nonlinear flight dynamics model for evaluation of helicopter handling qualities and control system design has been developed. The flight maneuvers conducted consist of the design specification requirements for symmetrical pullup and pushover, rolling pullout, vertical takeoff, yaw maneuvers both in sideward flight and at forward speed, gusts, and the effects of tail rotor loss. The program provides data on acceleration, rates, attitudes, and applied loads at all critical points within the maneuver. The correlation of the flight dynamics model with UH-60A Black Hawk flight test data for longitudinal, lateral, and rudder inputs is generally good.

P.T.H.

A79-10906 # Derivation of control loads for bearingless rotor systems. P. G. C. Dixon (Boeing Vertol Co., Philadelphia, Pa.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 7 p.

The paper presents a method for calculating the torsional stiffness of a bearingless rotor system flexure. Simple analyses of the torque required to produce axial deformation in a uniformly twisted flexure, nonuniform torsion of members of symmetrical open cross section without applied axial loading, and the rigidifying effects of axial tension on the flexure are performed. From these analyses, the constants in the expression for torque to twist a bearingless rotor blade flexure that is axially loaded by the blade centrifugal force are calculated.

P.T.H.

A79-10907 Impact of operational issues on design of advanced composite structures for Army helicopters. T. L. House and T. E. Condon (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 12 p.

The paper reviews the potential benefits available from composite structures for military aircraft and discusses those issues which must ultimately be considered in establishing realistic design criteria and related operational concepts. The interrelationships among operational damage, repair limitation, and overall aircraft operational effectiveness and maintenance support costs are discussed along with how each of these issues might affect design requirements.

P.T.H.

A79-10908 # A study of structural concepts for low radar cross section /LRCS/ fuselage configurations. B. W. Scruggs, Jr. (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.) and D. W. Lowry (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 20 p. 5 refs.

Three low radar cross section (LRCS) fuselage configurations were developed with the current UH-60A as a baseline, and several structural concepts were developed for these configurations and analyzed with respect to their effect on weight, cost, fail-safety, and maintainability. The effects on weight and cost of using advanced materials in the configurations were also evaluated.

P.T.H.

A79-10909 # The use of 3-D finite element analysis in the design of helicopter mechanical components. P. P. Dinyovszky and S. W. McKellip (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 5 p.

The results are presented of a research and development program directed at the evaluation of NASTRAN for the efficient finite element analysis of three-dimensional mechanical components commonly found in helicopter structures. The procedures developed during this study were used for the NASTRAN analysis of the CH-53A/D rotating swashplate. Comparison of the NASTRAN results for the stresses with experimental results demonstrate that excellent accuracy can be obtained with NASTRAN. (Author)

A79-10910 # A glance at Soviet helicopter design philosophy. W. Z. Stepniewski. In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 12 p.

The author gives a report on what current trends in Soviet helicopter design are, as judged from the contents of the book 'Helicopters' by Yatschenko et al. The optimization criteria that Soviet designers appear to be concerned with are (1) weight and transport effectiveness, (2) an economic integration of functional, producible, and operational effectiveness, and (3) general economic effect of total cost of all machines of a given type on the economy. Most attention in the review is directed at the studies of maximization of useful load.

P.T.H.

A79-10912 # Improved ballistic damage tolerant design through laminated metal construction. W. G. Degnan (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.), C. F. Hickey, Jr., and A. A. Anttil (U.S. Army, Army Materials and Mechanics Research Center, Watertown, Mass.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 12 p. 13 refs.

This paper presents the results of research conducted on adhesively bonded sheet metal laminate construction to increase ballistic damage tolerance. Test results are presented that show ballistic damage reduced by factors of 3:1 for 7.62mm and 4:1 for 12.7mm armor piercing projectile impact on laminated aluminum specimens. Modes of failure for monolithic and laminated structures are presented and discussed. Analysis of the test results shows a reduction of ballistic damage effects of 5:1 laminate-to-monolithic, with potential for even greater gains. Reduced lateral ballistic damage and increased residual static strength, both compared to monolithic structures, combine to give the desired improvement in post-ballistic damage strength.

(Author)

A79-10913 # The survivability of helicopters to rotor blade ballistic damage. H. Zinberg, J. Johnson (Bell Helicopter Textron, Fort Worth, Tex.), and H. Reddick (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 12 p. 11 refs.

This paper describes a program to investigate the survivability of helicopters to rotor blade ballistic damage. The ballistic threat used in the investigation was the 23mm HEI-T. Ballistic damage to the

rotor blade will alter the dynamics of the helicopter, impair the strength of the rotor, and change the aerodynamics in the region of the damage. These results were studied parametrically and the results are presented. A survivability model was developed to compute the damage inflicted by the projectile and to assess the capability of the helicopter to survive. This required developing a new helicopter dynamic simulation program and separate fatigue analyses for metal and composite blades. Ballistic and fatigue tests were performed to evaluate predictions made by the survivability model. (Author)

**A79-10914 # Damage tolerant design of the YAH-64 main rotor blade.** M. F. Symonds (Summa Corp., Hughes Helicopters Div., Culver City, Calif.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 10 p.

One of the main design goals for the YAH-64 helicopter was the capability for continued safe operation for at least 30 minutes after damage from any single hit by a 12.7mm armor-piercing incendiary (API) projectile and minimization of damage effects from an impact by a 23mm high explosive incendiary (HEI) missile. The paper describes how this and other design goals were attained in the main rotor blade. Damage tolerant design concepts incorporated in the main rotor blade include deep structural chord of 50.5% of blade chord; multispar design with redundancy and crack retardant, orient failure in spanwise direction, and vent pressure in spanwise direction; use of AM355CRT stainless steel; fiberglass used as crack retardant; redundant root fittings and root doublers; and redundant tip design.

P.T.H.

**A79-10916 # Composite rotor hub.** I. II. R. J. Mayerjak (Kaman Aerospace Corp., Bloomfield, Conn.) and G. T. Singley, III (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 8 p. Grant No. DAAJ02-75-C-0013.

The paper describes the testing in fatigue at design loads and the static testing under limit loads of the composite hub being developed for the CH-54B helicopter. The tests were designed so as not to destroy the single specimen in existence. The tests demonstrated fatigue strength sufficient to survive 1 million cycles of the fatigue design loads. A residual strength after fatigue testing sufficient to support the most critical flight loads was demonstrated. Adequate stiffness for dynamic compatibility with the rotor controls and drive train was also demonstrated. Information on the importance of secondary bending in the plates was obtained.

P.T.H.

**A79-10917 # Survey of the application of reinforced composites in European helicopters.** G. C. Alling, Jr. (U.S. Army, Foreign Science and Technology Center, Charlottesville, Va.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 6 p. 13 refs.

The paper discusses briefly some of the uses to which composite materials have been put in helicopter rotor blades and main rotor hubs. The BO-105 rotor blade is an all-composite structure consisting of a C spar, a foam-stabilized trailing edge, and a glass-cloth skin. Fabrication is entirely by hand. The main rotor blade for the AS-350 has a mechanically wound spar and skin, and may be one of the least expensive blades in the world. The Starflex rotor hub employs S-glass-reinforced epoxy and elastomeric bearings to achieve a drastic simplification of the rotor head. The hub star consists of a built-up laminate of glass cloth. This hub is only 60% as heavy as a comparable fully articulated hub and costs only one-fourth as much to produce.

P.T.H.

**A79-10918 # Advanced technology helicopter landing gear.** W. T. Alexander, Jr. (U.S. Army, Aviation Research and Development Command, Fort Eustis, Va.) and R. E. Goodall (Summa Corp., Hughes Helicopters Div., Culver City, Calif.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 9 p. 6 refs.

This report covers work performed on the advanced helicopter landing gear program. The objectives of the program were to design, fabricate, and test a wheel-type advanced main landing gear concept possessing high-energy-absorbing characteristics for helicopters in the 15,000-pound class. These objectives were achieved by formulating design criteria through a data search, choosing the most cost-effective composite material, and by design analysis, selecting the most promising landing gear concept. This concept used graphite epoxy as a structural material to fabricate the trailing arm of the main landing gear of the Hughes YAH-64 helicopter by wet-filament-winding (WFW). The graphite arm was successfully tested, demonstrating the practicality of employing composite structures in the construction of high-energy-absorbing landing gear components. (Author)

**A79-10919 # Development of a multitubular spar composite main rotor blade.** R. E. Head (Summa Corp., Hughes Helicopters Div., Culver City, Calif.) and N. J. Calopodas (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 9 p.

A multitubular spar (MTS) composite main rotor blade was developed for the AH-1G helicopter in the original production metal geometry. To minimize material cost, the wet filament winding (WFW) technique was used. The spar structure is spread over the forward half of the chord to provide ballistic survivability against the 23mm HEI-T threat. The blade passed all fatigue, static, repairability, and ballistic tolerance tests. Radar absorbing material moded into the leading edge made a significant reduction in radar cross section. Flight tests exploring 80% of the AH-1G flight envelope were conducted. A comparison of blade loads in similar flight conditions shows that the MTS and the metal blade loads are similar. Cost analysis showed that the MTS blade could be produced and sold for a lower price than the metal blade.

P.T.H.

**A79-10920 # Boeing Vertol bearingless main rotor structural design approach using advanced composites.** G. J. Wehnert, M. W. Sheffler (Boeing Vertol Co., Philadelphia, Pa.), and H. K. Reddick (U.S. Army, Air Mobility Laboratory, Fort Eustis, Va.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 8 p.

The bearingless main rotor (BMR) system has no pitch, flap, or lead/lag bearings. The twin fiberglass channel beams are the principal structural members which accommodate pitch inputs and normal flap and lag motions, as well as provide for the retention of the blades against centrifugal force. The material is tailored to meet the frequency criteria and still have low stress levels by placing the peak flap, chord, and torsional stress levels at different spanwise locations. The paper describes methods of analyzing the loads on the system and also the results of testing the system for its load responses. This formed the basis for life calculations for the components. Verification of fatigue analysis is in progress.

P.T.H.

A79-10921 # Ultrasonic welding /solid state bonding/ of aircraft structure - Fact or fancy. J. Devine, G. K. Dingle (Summa Corp., Hughes Helicopters Div., Culver City, Calif.), and R. G. Vollmer (U.S. Army, Aviation Research and Development Command, Fort Eustis, Va.). In: Conference on Helicopter Structures Technology, Moffett Field, Calif., November 16-18, 1977, Proceedings. (A79-10903 01-05) Moffett Field, Calif., U.S. Army Air Mobility Research and Development Laboratory, 1978. 24 p. 8 refs.

The paper describes the ultrasonic welding of an inner skin to an outer skin of a YAH-64 helicopter access door. It was found that the ultrasonically welded access door had superior strength, reduced weight, and reduced cost as compared with other joining techniques.

P.T.H.

A79-14971 \* Design and evaluation of flight directors for V/STOL aircraft. R. A. Hess (NASA, Ames Research Center, Moffett Field, Calif.). In: Conference on Decision and Control, and Symposium on Adaptive Processes, 16th, and Special Symposium on Fuzzy Set Theory and Applications, New Orleans, La., December 7-9, 1977, Proceedings. Volume 1. (A79-14957 04-63) Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1977, p. 241-246. 8 refs.

A brief review of model-based techniques for the design of aircraft flight directors is undertaken. An analytical director design technique which utilizes an optimal control model of the human pilot is then discussed in more detail. The analytical and experimental results of three specific director design studies are discussed, all involving control of a light utility helicopter. Finally, a general design methodology is discussed which can aid in the specification of pilot-centered display requirements.

(Author)

A79-14973 \* Lie theoretic aspects of the Riccati equation. R. Hermann (Harvard University, Cambridge, Mass.) and C. Martin (NASA, Ames Research Center, Moffett Field, Calif.). In: Conference on Decision and Control, and Symposium on Adaptive Processes, 16th, and Special Symposium on Fuzzy Set Theory and Applications, New Orleans, La., December 7-9, 1977, Proceedings. Volume 1. (A79-14957 04-63) Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1977, p. 265-270. 9 refs.

Various features of the application of Lie theory to matrix Riccati equations, of basic importance in control and system theories, are discussed. Particular consideration is given to centralizer foliation, the Cartan decomposition, matrix Riccati equations, systems on Grassmannians, local analysis near a zero point of a vector field, linearization in homogeneous space, the tangent bundle in terms of partitioned matrices, and stability properties of fixed points of Riccati vector fields.

B.J.

A79-15258 \* Microwave diagnostic for the determination of the electron temperature of a low density shock-heated argon plasma. C. P. Schneider (München, Hochschule der Bundeswehr, Munich, West Germany) and R. J. Exberger (NASA, Ames Research Center, Moffett Field, Calif.). In: Shock tube and shock wave research; Proceedings of the Eleventh International Symposium, Seattle, Wash., July 11-14, 1977. (A79-15207 04-34) Seattle, Wash., University of Washington Press, 1978, p. 482-489. 7 refs.

The diffraction, defocusing and beam bending effects of microwaves transmitted through a bounded shock-heated argon plasma with low electron density are investigated with the purpose of developing an accurate method for electron temperature ( $T_e$ ) determination. This report describes the evaluation technique and presents results for an argon plasma with pressure between 3 and 10 torr, and  $T_2$  between 5500 and 9500 K. The electron temperature values obtained have a range of uncertainty between -20% and +10% only. The electron temperature is equal or lower by approximately 1000 K in comparison to the heavy particle temperature ( $T_2$ ).

(Author)

A79-15636 \* # Status and summary of laser energy conversion. G. Lee (NASA, Ames Research Center, Moffett Field, Calif.). In: Radiation energy conversion in space; Conference, 3rd, Moffett Field, Calif., January 26-28, 1978, Technical Papers. (A79-15601 04-44) New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 549-565. 33 refs.

This paper presents a survey of the status of laser energy converters. Since the inception of these devices in the early 1970's, significant advances have been made in understanding the basic conversion processes. Numerous theoretical and experimental studies have indicated that laser energy can be converted at wavelengths from the ultraviolet to the far-infrared. These converters can be classified into five general categories: photovoltaics, heat engines, thermoelectric, optical diode, and photochemical. The conversion can be directly into electricity (such as the photovoltaic, thermoelectric, and optical diode) or it can go through an intermediate stage of conversion to mechanical energy, as in the heat engines. The photochemical converters result in storable energy such as hydrogen. Projected conversion efficiencies range from about 30% for the photochemical to nearly 75% for the heat engines. (Author)

A79-18100 \* # Transonic flow about a two-dimensional airfoil inviscid and turbulent flow properties. D. A. Johnson (NASA, Ames Research Center, Moffett Field, Calif.) and W. D. Bachalo (NASA, Ames Research Center, Moffett Field; Spectron Development Laboratories, Inc., Costa Mesa, Calif.). American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 11th, Seattle, Wash., July 10-12, 1978, Paper 78-1117. 21 p. 17 refs.

Flow-field measurements are presented for a symmetrical NACA 64A010 airfoil section at transonic conditions. Measurements were obtained for three angles of attack with the free-stream Mach number fixed at 0.8. The cases studied included a weak shock wave/boundary layer interaction, an interaction of medium strength with mild separation, and an interaction of sufficient strength to produce a shock-induced stall situation. Two nonintrusive optical techniques, laser velocimetry and holographic interferometry, were used to characterize the flows. The results include Mach number contours and flow angle distributions in the inviscid flow regions, and turbulent flow properties, including the turbulent Reynolds stresses, of the upper surface viscous layers, and of the rear-wake. The turbulent flow measurements reveal that the turbulence fluctuations attain equilibrium with the local mean flow much faster than previously expected.

(Author)

A79-18127 \* # Analytic investigation of advancing blade drag reduction by tip modifications. M. E. Tauber (NASA, Ames Research Center, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. (A79-18126 05-01) Washington, D.C., American Helicopter Society, 1978. 10 p. 13 refs. (AHS 78-01)

Analytic techniques were applied to study the effect on the performance of the nonlifting advancing blade when the outboard 5% of the blade is modified to reduce drag. The tip modifications studied consisted of reducing airfoil thickness, sweepback, and planform taper. The reductions in instantaneous drag and torque were calculated for tip speed ratios from about 0.19 to 0.30, corresponding to advancing blade tip Mach numbers of 0.855 to 0.936, respectively. Approximations required in the analysis introduce uncertainties into the computed absolute values of drag and torque; however, the differences in the quantities should be a fairly reliable measure of the effect of changing tip geometry. For example, at the highest tip speed, instantaneous drag and torque were reduced by 20% and 24%, respectively, for tip sweep of 40 deg on a blade using an NACA 0010 airfoil and by comparable amounts for 30-deg sweep on a blade having an NACA 0012 airfoil section. The present method should prove to be a useful, inexpensive technique for identifying promising configurations for additional study and testing. (Author)

A79-18129 \* # Full-scale wind tunnel test of a modern helicopter main rotor - Investigation of tip Mach number effects and comparisons of four tip shapes. R. H. Stroub (NASA, Ames Research Center; U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. (A79-18126 05-01) Washington, D.C., American Helicopter Society, 1978. 7 p. (AHS 78-03)

A test of a full-scale helicopter rotor was conducted in the NASA Ames Research Center 40- by 80-Foot Wind Tunnel to investigate performance characteristics of rotors with various tip geometries. Four blade tip geometries were investigated: rectangular, trapezoidal, swept rectangular, and swept trapezoidal. The investigation was accomplished over an advance ratio range of 0.2 to 0.375 and an advancing blade Mach number range from 0.72 up to 0.97. On a power basis, the best overall tip geometry was the swept trapezoidal configuration.

(Author)

A79-18153 \* # Analytical design of a high performance stability and control augmentation system for a hingeless rotor helicopter. K. Miyajima (NASA, Ames Research Center, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. (A79-18126 05-01) Washington, D.C., American Helicopter Society, 1978. 16 p. 14 refs. (AHS 78-27)

A stability and control augmentation system (SCAS) was designed based on a set of comprehensive performance criteria. Linear optimal control theory was applied to determine appropriate feedback gains for the stability augmentation system (SAS). The helicopter was represented by six-degree-of-freedom rigid body equations of motion and constant factors were used as weightings for state and control variables. The ratio of these factors was employed as a parameter for SAS analysis and values of the feedback gains were selected on this basis to satisfy three of the performance criteria for full and partial state feedback systems. A least squares design method was then applied to determine control augmentation system (CAS) cross feed gains to satisfy the remaining seven performance criteria. The SCAS gains were then evaluated by nine degree-of-freedom equations which include flapping motion and conclusions drawn concerning the necessity of including the pitch/regressing and roll/regressing modes in SCAS analyses.

(Author)

A79-18155 \* # A piloted simulator investigation of augmentation systems to improve helicopter nap-of-the-earth handling qualities. R. T. N. Chen, P. D. Talbot, R. M. Gerdes, and D. C. Dugan (NASA, Ames Research Center, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. (A79-18126 05-01) Washington, D.C., American Helicopter Society, 1978. 23 p. (AHS 78-29)

A piloted simulation study assessed various levels of stability and control augmentation designed to improve the handling qualities of several helicopters in nap-of-the-earth (NOE) flight. Five basic single rotor helicopters - one teetering, two articulated, and two hingeless - which were found to have a variety of major deficiencies in a previous fixed-based simulator study were selected as baseline configurations. The stability and control augmentation systems (SCAS) include simple control augmentation systems (CAS) to decouple pitch and yaw responses due to collective input and to quicken the pitch and roll control responses; SCAS of rate command type designed to optimize the sensitivity and damping and to decouple the pitch-roll due to aircraft angular rate; and attitude command type SCAS. Pilot ratings and commentary are presented as well as performance data related to the task. SCAS control usage and their gain levels associated with specific rotor type are also discussed.

(Author)

A79-18171 \* Definition and analytical evaluation of a power management system for tilt-rotor aircraft. J. J. Morris and H. R. Alexander (Boeing Vertol Co., Philadelphia, Pa.). In: American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. (A79-18126 05-01) Washington, D.C., American Helicopter Society, 1978. 8 p. 6 refs. Research supported by the Boeing Vertol Co.; Contracts No. NAS2-6505; No. NAS2-6598. (AHS 78-48)

The paper reviews the special design criteria which apply to power management in a tilt-rotor aircraft. These include the need for accurate and fast control of rpm and thrust, while accounting for the dynamic interactions between rotor systems caused by cross-shafting and aircraft lateral/directional response. The power management system is also required to provide acceptable high speed sensitivity to longitudinal turbulence. It is shown that the criteria can best be met using a single governor adjusting the collective pitch by an amount proportional to a combination of the average rpm and the integral of the average rpm of the two rotors. This system is evaluated and compared with other candidate systems in hover and cruise flight.

(Author)

A79-18181 \* # Wind-tunnel test results of a full-scale multicyclic controllable twist rotor. J. L. McCloud, III (NASA, Ames Research Center, Moffett Field, Calif.) and A. L. Weisbrich (Kaman Aerospace Corp., Bloomfield, Conn.). In: American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. (A79-18126 05-01) Washington, D.C., American Helicopter Society, 1978. 20 p. 5 refs. (AHS 78-60)

Results of wind tunnel testing of a multicyclic controllable twist rotor at several flight conditions and advance ratios of 0.22 and 0.33 are evaluated. It is found that blade flatwise bending moments and root control actuator loads (fixed system) can be reduced with multicyclic control. Flatwise bending moment reductions of 22-30% with concurrent 83% reductions in control loads were predicted. Analysis of profile power changes indicates a decrease in profile power coefficient of 0.00016, corresponding to a loss of 0.12 sq m of equivalent drag area.

P.T.H.

A79-18185 \* # Flap-lag-torsion aeroelastic stability of circulation-controlled rotors in hover. I. Chopra (NASA, Ames Research Center, Moffett Field, Calif.) and W. Johnson (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. (A79-18126 05-01) Washington, D.C., American Helicopter Society, 1978. 15 p. 5 refs. (AHS 78-64)

The results of a theoretical investigation of the flap-lag-torsion stability of circulation controlled rotors in hover are presented. Stability boundaries are presented as a function of thrust and lag frequency, at several levels of blowing coefficient, for flap frequencies of 1.1/rev and 1.8/ rev. The effects of several parameters on the blade flap-lag stability are examined, including structural damping, structural coupling, pitch-lag and pitch-flap coupling, and the blade feathering motion. The trailing edge blowing can have a major impact on the blade aeroelastic stability, which should be considered in the rotor design. The implications of these results for the current CCR and X-Wing rotocraft designs are considered.

(Author)

A79-18422 \* DSPOBJ - System for display of multiple sets of three-dimensional data. J. B. Ashbaugh (NASA, Ames Research Center, Moffett Field, Calif.; USAF, Washington, D.C.), D. P. Roland, and L. F. Laird (NASA, Ames Research Center, Moffett Field, Calif.; Informatics-PMI, Inc., Palo Alto, Calif.). *Computers and Graphics*, vol. 3, no. 2-3, 1978, p. 63-70. Contract No. NAS2-6914-25.

DSPOBJ is a FORTRAN subroutine to control the display of three-dimensional line networks on a stand-alone, general-purpose, interactive computer graphics system. The program controls the creation and manipulation of transformation matrices for the display and control of multiple sets of line networks. It provides advanced graphics features such as independent and global scaling, rotation and translation, cross-sectioning, reflection, and simultaneous display of four views.

P.T.H.

A79-18674 \* # Role of helicopters in airport access. J. S. Dajani (Stanford University, Stanford, Calif.) and W. J. Snyder (NASA, Ames Research Center, Helicopter Systems Office, Moffett Field, Calif.). *ASCE, Transportation Engineering Journal*, vol. 104, Nov. 1978, p. 799-815. 8 refs. Grant No. NSG-1121.

The paper briefly reviews the role of helicopter systems in the provision of airport access services and evaluates the potential for the future development of such services in major metropolitan areas in the United States. The evaluation is based on a computer simulation of potential helicopter system proposed for 20 metropolitan areas. The simulation provides two indicators that are used to gage the extent of the feasibility of developing successful systems in these areas: (1) the cost per seat mile, and (2) the break-even number of passengers, expressed as a percentage of total air travelers. It is found that a few metropolitan areas presently have the potential of marginally supporting intra-urban helicopter airport access service. The access systems offer a viable alternative for air passengers placing a high value on their time, and provides the opportunity for better integrating the air transportation service of multiple airports in a given urban region.

S.D.

A79-18674 \* # Recent progress in rotorcraft and powered-lift research. L. Roberts (NASA, Ames Research Center, Moffett Field, Calif.). In: European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings. Volume 2. (A79-18637 06-01) Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 41-0 to 41-18. 9 refs.

The paper reviews some of the recent technological developments in the United States in the field of rotorcraft and powered-lift research, with primary emphasis on the compound helicopter and the augmentor thrust approaches to vertical flight. The last several years have seen significant developments in the state of the art through the combined use of wind tunnels, simulators, and research aircraft. The results of several representative studies are discussed to demonstrate the improvements that have been made in several of the important vehicle-related parameters. The prospect for further advances is also discussed.

B.J.

A79-18703 \* # Flight research capabilities of the NASA/Army Rotor Systems Research Aircraft. S. White, Jr. (NASA, Ames Research Center, Moffett Field, Calif.) and G. W. Condon (U.S. Army, Research and Technology Laboratories, Hampton, Va.). In: European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings. Volume 2. (A79-18637 06-01) Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 72-0 to 72-27.

After a brief description of the Rotor Systems Research Aircraft (RSRA), the paper reviews their flight capabilities and limitations. A favorable assessment is given to the expected research capabilities of the RSRA. The structural limitations should not significantly constrain the flight envelope for research operations; the handling qualities, though not optimum, are within the parameters originally predicted; and there are no fundamental dynamics problems. Although the accuracy of the force and moment measurement system has not yet been quantified by calibration, it is expected to be acceptable after calibration.

B.J.

A79-18751 \* # Interaction of a strong blast wave with a free surface. A. Falade (NASA, Ames Research Center, Moffett Field; California, University, Berkeley, Calif.) and M. Holt (California, University, Berkeley, Calif.). *Physics of Fluids*, vol. 21, Oct. 1978, p. 1702-1708. 8 refs.

When a point source explosion is initiated at the ocean surface, the shock propagated into the water is reflected at the surface as a centered expansion wave. The solution in the neighborhood of the interaction point is obtained by writing the equations of motion in the appropriate similarity variables and then changing the independent variables to polar coordinates based at the interaction point. From the zero-order solution of the resulting equations the slopes of boundaries at the interaction point are obtained. A first-order perturbation of this solution provides more accurate representation of the flow variables and the curvature of the shock surface near the interaction point.

(Author)

A79-18752 \* # Surface waves generated by shallow underwater explosions. A. Falade (NASA, Ames Research Center, Moffett Field; California, University, Berkeley, Calif.) and M. Holt (California, University, Berkeley, Calif.). *Physics of Fluids*, vol. 21, Oct. 1978, p. 1709-1716. 14 refs.

Surface water waves generated by surface and near surface point explosions are calculated. Taking the impulse distribution imparted at the water surface by the explosion as the overriding mechanism for transferring energy of the explosive to surface wave motion, the linearized theory of Kranzer and Keller is used to obtain the wave displacement in the far field. The impulse distribution is obtained by integrating the pressure wave over an appropriate time interval on a horizontal surface just beneath the undisturbed water surface. For surface explosions, a modified form of the similarity method first used by Collins and Holt is used to obtain the flow field. In the case of submerged explosions, the flow field is estimated by making necessary modifications to Sedov's similarity solution to account for the venting that accompanies the interaction of the leading (blast) wave with the ocean surface. Surface waves generated by a charge at six depths of placement (0.15 m, 0.30 m, 0.61 m, 0.91 m, 1.37 m, 3.05 m) are considered in addition to surface explosions. The results seem to support the existence of an upper critical depth phenomenon (of the type already established for chemical explosions) for point (nuclear) explosions.

(Author)

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A79-19479 \* # Axisymmetric internal flows with shocks. M. H. Rizk (Flow Research Co., Kent, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0015*. 8 p. 7 refs. Contracts No. NAS2-8847; No. NAS2-9699.

Internal flow problems with supersonic entrance conditions and subsonic exit conditions are studied. The suitability of applying the transonic small disturbance theory to internal flows is examined and found to be very limited. The full inviscid equations in nonconservative form are solved by relaxation. Jump conditions which conserve mass and normal momentum are applied explicitly at shock waves. This method is suitable for solving flows which include supersonic-subsonic shock waves nearly normal to the streamlines.

(Author)

A79-19514 \* # Supercritical wing design using numerical optimization and comparisons with experiment. M. E. Lores, P. R. Smith (Lockheed-Georgia Co., Marietta, Ga.), and R. M. Hicks (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0065*. 11 p. 12 refs.

A numerical minimization scheme is used in conjunction with two-dimensional and three-dimensional inviscid transonic flow analysis codes to provide procedures for wing leading edge aerodynamic design. The procedures are demonstrated in the design of a new leading edge to improve C-141 cruise performance. For the high aspect ratio moderately swept C-141 wing, the 2-D procedure is shown to yield results which are in close agreement with those obtained using the 3-D technique. Although the 2-D approach uses much less computation time than the 3-D technique, the latter requires fewer manhours than the former. Comparisons of predicted and wind tunnel measured performance improvements are presented which verify the design procedures. (Author)

**A79-19523 \* #** An efficient algorithm for numerical airfoil optimization. G. N. Vanderplaats (NASA, Ames Research Center, V/STOL Systems Office, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0079.* 9 p. 11 refs.

A new optimization algorithm is presented. The method is based on sequential application of a second-order Taylor's series approximation to the airfoil characteristics. Compared to previous methods, design efficiency improvements of more than a factor of 2 are demonstrated. If multiple optimizations are performed, the efficiency improvements are more dramatic due to the ability of the technique to utilize existing data. The method is demonstrated by application to subsonic and transonic airfoil design but is a general optimization technique and is not limited to a particular application or aerodynamic analysis. (Author)

**A79-19534 \* #** U.S. aerospace industry opinion of the effect of computer-aided prediction-design technology on future wind-tunnel test requirements for aircraft development programs. S. L. Treon (NASA, Ames Research Center, Aerodynamics Div., Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0107.* 18 p. 19 refs.

A survey of the U.S. aerospace industry in late 1977 suggests that there will be an increasing use of computer-aided prediction-design technology (CPD Tech) in the aircraft development process but that, overall, only a modest reduction in wind-tunnel test requirements from the current level is expected in the period through 1995. Opinions were received from key spokesmen in 23 of the 26 solicited major companies or corporate divisions involved in the design and manufacture of nonrotary wing aircraft. Development programs for nine types of aircraft related to test phases and wind-tunnel size and speed range were considered. M.L.

**A79-19544 \* #** A study of the blown flap/jet flap analogy. G. R. Hough (Vought Advanced Technology Center, Inc., Dallas, Tex.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0119.* 9 p. 21 refs. Contract No. NAS2-8115.

A study of the blown flap/jet flap analogy has been undertaken. Analytical predictions were made using both improved lifting line and optimized vortex lattice models for the jet flap. Results were compared with experimental data for three propulsive lift systems; the jet augmented flap, the externally blown flap, and the upper surface blown flap. Force increments due to changes in geometry and jet parameters were well approximated in most cases, although the absolute values of the aerodynamic forces were usually underestimated. The relatively simple jet-flap models gave performance predictions of accuracy comparable to more complex analyses. (Author)

**A79-19597 \* #** Unsteady thin airfoil theory for transonic flows with embedded shocks. M. H. Williams (Princeton University, Princeton, N.J.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0204.* 12 p. 19 refs. Grant No. NSG-2194.

Classical unsteady thin airfoil theory fails for low frequencies at the subsonic freestream Mach number, because of the formation of a shock wave that shields the forward region of the airfoil from aft generated disturbances. In the present paper, the classical thin airfoil theory is modified to account for the presence and induced motion of such shocks. The modification consists of taking the steady local Mach number to be a simple step discontinuity, normal to the undisturbed flow, separating two uniform regions. Predicted regions are shown to correlate well both with the experiment and finite difference calculations. V.P.

**A79-19679 \* #** Computation of aerodynamic interference effects on oscillating airfoils with controls in ventilated subsonic wind tunnels. J. A. Fromme and M. A. Golberg (Nevada, University, Las Vegas, Nev.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0346.* 14 p. 37 refs. Grant No. NSG-2140.

Lift interference effects are discussed based on Bland's (1968) integral equation. A mathematical existence theory is utilized for which convergence of the numerical method has been proved for general (square-integrable) downwashes. Airloads are computed using orthogonal airfoil polynomial pairs in conjunction with a collocation method which is numerically equivalent to Galerkin's method and complex least squares. Convergence exhibits exponentially decreasing error with the number n of collocation points for smooth downwashes, whereas errors are proportional to 1/n for discontinuous downwashes. The latter can be reduced to 1/n to the m+1 power with mth-order Richardson extrapolation (by using m = 2, hundred-fold error reductions were obtained with only a 13% increase of computer time). Numerical results are presented showing acoustic resonance, as well as the effect of Mach number, ventilation, height-to-chord ratio, and mode shape on wind-tunnel interference. Excellent agreement with experiment is obtained in steady flow, and good agreement is obtained for unsteady flow. (Author)

**A79-19681 \* #** Supersonic propeller noise in a uniform flow. W.-H. Jou (Flow Research Co., Kent, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0348.* 7 p. 8 refs. Contract No. NAS2-9807.

The reported investigation is concerned with an extension of a theory presented by Hawkins and Lowson (1974). The extension considers also forward flight. Attention is given to the retarded potential solution of the convected wave equation, the Fourier components of acoustic pressure, the zones of relative silence and Doppler amplification, and the asymptotic evaluation of a noise field for a large wave number. The discussed analysis provides the Fourier coefficients of the acoustic signature of a supersonic rotor in a uniform flow. The results are represented by an integral over the blade planform which must be evaluated numerically. The fast Fourier transform can be employed for the Fourier inversion. G.R.

**A79-21520 \* #** Lifting-line theory of oblique wings in transonic flows. H. K. Cheng and S. Y. Meng (Southern California, University, Los Angeles, Calif.). *AIAA Journal, vol. 17, Jan. 1979, p. 121-124.* 14 refs. Contracts No. N00014-75-C-0520; No. NCR-730-501; No. NCA2-OR-730-601.

Three-dimensional corrections to the nonlinear mixed flow

admitted by a high-aspect-ratio swept wing of practical interest are analyzed by solving a perturbation problem and matching its solution to that of an outer flow. The latter is identified with a linear solution involving a lifting line, but the centerline of the planform is not required to be straight and unyawed. The existence of a similarity in the three-dimensional flow structure for a certain oblique-wing geometry is demonstrated, along with a solution to the reduced problem in a high-subcritical case.

F.G.M.

A79-23516 \* # Numerical simulation of steady supersonic viscous flow. L. B. Schiff and J. L. Steger (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0130.* 20 p. 31 refs.

A noniterative, implicit, space-marching, finite-difference algorithm is developed for the steady thin-layer Navier-Stokes equations in conservation-law-form. The numerical algorithm is applicable to steady supersonic viscous flow over bodies of arbitrary shape. In addition, the same code can be used to compute supersonic inviscid flow or three-dimensional boundary layers. Computed results from two-dimensional and three-dimensional versions of the numerical algorithm are in good agreement with those obtained from more costly time-marching techniques.

(Author)

A79-23526 \* # Computational optimization and wind tunnel test of transonic wing designs. H. P. Haney, R. R. Johnson (Vought Corp., Dallas, Tex.), and R. M. Hicks (NASA, Ames Research Center, Aerodynamics Research Branch, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0080.* 12 p. 7 refs.

A practical procedure for the optimum design of transonic wings is demonstrated. The procedure uses an optimization program based on the method of feasible directions coupled with an aerodynamic analysis program which solves the three-dimensional potential equation for subsonic through transonic flow. Two new wings for the A-7 aircraft were designed by using the optimization procedure to achieve specified surface pressure distributions. The new wings, along with the existing A-7 wing, were tested in the Ames 11-foot transonic wind tunnel. The experimental data show that all of the performance goals were met.

(Author)

A79-23575 \* # An experimental investigation of the flow field of a rectangular wall jet. C. Horne and K. Karamcheti (Stanford University, Stanford, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0208.* 19 p. 11 refs. Grants No. NsG-2007; No. NsG-2215.

The structure of a laminar, rectangular wall jet developing from an initially parabolic velocity profile was investigated with measurements of the mean and fluctuating velocity field, and with Schlieren flow visualization. The effects on mean and fluctuating velocity fields of changes in the jet Reynolds number over the range of from 0 to 4800, and of various wall lengths ranging from 0 to 312 jet widths were studied. For a given wall length and Reynolds number, disturbances in the flow field were regular and periodic, and of a constant frequency in a large region of the flow field. Small, self-excited disturbances at the nozzle exit were observed to grow exponentially with downstream distance, and roll up to form a convecting array of discrete vortices. For certain values of wall length and jet speed, discrete audible tones were detected, and appeared to be associated with an enhancement of the regularity and stability of the vortex array.

(Author)

A79-24179 \* # Calculate<sup>d</sup> hovering helicopter flight dynamics with a circulation-controlled rotor. W. Johnson (NASA, Ames Research Center; U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.) and I. Chopra (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Aircraft*, vol. 16, Feb. 1979, p. 124-128. 5 refs.

The flight dynamics of a hovering helicopter with a circulation-controlled rotor are analyzed. The influence of the rotor blowing coefficient on the calculated eigenvalues of the helicopter motion is examined for a range of values of the rotor lift, and the blade flap frequency. The control characteristics of a helicopter with a circulation-controlled rotor are discussed. The principal effect of the blowing is a reduction in the rotor speed stability derivative. Above a critical level of blowing coefficient, which depends on the flap frequency and rotor lift, negative speed stability is produced and the dynamic characteristics of the helicopter are radically altered. The handling qualities of a helicopter with negative speed stability are probably unacceptable without a stability augmentation system.

(Author)

A79-25881 \* Propeller slipstream wing interactions at Mach no. 0.8. D. P. Bencze, R. C. Smith (NASA, Ames Research Center, Moffett Field, Calif.), H. R. Welge, and J. P. Crowder (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, Aerospace Meeting, San Diego, Calif., Nov. 27-30, 1978, Paper 780997.* 11 p. 11 refs.

Configuration and results of a wind tunnel test of the aerodynamic interactions between propeller slipstream and a supercritical wing at transonic Mach numbers are discussed. The test was conducted over a free-stream Mach number range from 0.7 to 0.84, with the slipstream simulator and the wing-body model installed in the tunnel. The angle of attack and the spanning lift coefficients were varied from 1 to 3 deg and from 0.4 to 0.7 deg respectively, while the slipstream swirl angle was varied from 0 to 11 deg with an upwash on the inboard side of the wing. It was found that at a free-stream Mach number of 0.8 and a lift coefficient of 0.5, incremental drag results for 7 deg of swirl and a slipstream Mach number of 0.87 indicated a penalty equivalent to a 0.024 loss in propeller efficiency, whereas at 11 deg the drag increment was favorable. Swirl had significant effects on the chordwise pressure distributions of the inboard section of the wing within the slipstream. Neither surface nor wake pressures showed signs of significant flow separation induced by the slipstream.

A.A.

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A79-26142 \* A sequential method for spline approximation with variable knots. A. M. Mier Muth (Instituto de Investigaciones Eléctricas, Mexico City, Mexico) and A. S. Willsky (MIT, Cambridge, Mass.). *International Journal of Systems Science*, vol. 9, no. 9, 1978, p. 1055-1067. 15 refs. Grant No. NGL-22-009-124; Contract No. F41609-76-C-0009.

In this paper we describe a method for approximating a waveform by a spline. The method is quite efficient, as the data are processed sequentially. The basis of the approach is to view the approximation problem as a question of estimation of a polynomial in noise, with the possibility of abrupt changes in the highest derivative. This allows us to bring several powerful statistical signal processing tools into play. We also present some initial results on the application of our technique to the processing of electrocardiograms, where the knot locations themselves may be some of the most important pieces of diagnostic information.

(Author)

**A79-26939 \* #** An acoustical study of the XV-15 Tilt Rotor Research Aircraft. A. Lee (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.) and M. Mosher (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 5th, Seattle, Wash., Mar. 12-14, 1979, Paper 79-0612.* 7 p.

Acoustic data were obtained during a full-scale test of the XV-15 Tilt Rotor Research Aircraft in the Ames 40- by 80-Foot Wind Tunnel. The XV-15 has two 25-ft-diameter, three-bladed rotors at the tips of a 32-ft span wing. The rotors are used as lifting rotors, as propellers, and in various intermediate stages. Acoustic waveforms, dBA, and spectra as functions of different rotor conditions are presented and discussed. The noise level was found to be sensitive to change in rotor-disk angle of attack in the helicopter configuration. Much higher noise levels and harmonic contents were found in the helicopter mode than in the airplane mode. The measurements are compared with existing theoretical predictions which include wind-tunnel wall reflections.

(Author)

**A79-27371 \* #** XV-15 Tilt Rotor Research Aircraft - Program report. J. P. Magee (NASA, Ames Research Center; U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.) and K. G. Wernicke (Bell Helicopter Textron, Fort Worth, Tex.). In: *Atlantic Aeronautical Conference, Williamsburg, Va., March 26-28, 1979, Technical Papers. (A79-27351 10-05)* New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 201-210. 15 refs. (AIAA 79-0704)

This paper is a status report of the NASA/Army XV-15 Project. The basic tilt-rotor concept and the XV-15 Tilt-Rotor Research Aircraft are discussed and some results of full-scale wind-tunnel tests in the Ames 40- by 80-Foot Wind Tunnel are presented. Flight-test data are included to give preliminary performance, noise, and vibration data in hover and as far into transition flight as are available at the time of presentation. Information concerning vehicle aerodynamics and airloads obtained as a result of both wind-tunnel and flight tests are provided with some conclusions as to the ramifications of the data in terms of design criteria and configuration layout.

(Author)

**A79-28290 \* #** Combined strength and aeroelastic wing synthesis via constraint approximation. J. Mullen, Jr. (Nielsen Engineering and Research, Inc., Mountain View, Calif.). In: *Structures, Structural Dynamics, and Materials Conference, 20th, St. Louis, Mo., April 4-6, 1979, Technical Papers on Dynamics and Loads. (A79-28251 10-39)* New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 356-366. 24 refs. Contract No. NAS2-8558. (AIAA 79-0724)

A numerical optimization program using constraint approximations for preliminary sizing of wing structural design parameters to satisfy simultaneous strength and aeroelastic requirements is described. The effects of wing flexibility on loads and flutter are included. The iterative procedure approximates wing internal load distributions and flutter response in generating design constraints. Though a linear Taylor series approximation to the variation of flutter speed is made, constraints in general are formulated as non-linear and solved in a minimum weight problem using a feasible directions search. The technique is demonstrated for the determination of the optimal ply orientations and for simultaneous sizing for strength and flutter with simple constraint approximations. (Author)

**A79-28962 \* #** Analysis of flight effects on noise radiation from dual-flow coaxial jets. R. Dash (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 5th, Seattle, Wash., Mar. 12-14, 1979, Paper 79-0619.* 16 p. 23 refs.

A theoretical study has been made of the effects of flight on noise from dual-flow coaxial jets. The theory is based on an instability free, vortex sheet flow model. It is shown that the flight effects are more favorable (and hence produce less forward-arc amplification) for coaxial jets than for single-stream jets. Further, the theory predicts that, like the single-stream jet case, flight effects induce noise amplification in the forward quadrant and attenuation in the aft quadrant and have virtually no effect at  $\theta = 90^\circ$  to the jet axis, where  $\theta$  is the angle between the directions of convection and emission at the retarded time. Amplification in the forward quadrant diminishes as the inner flow velocity increases and becomes optimum when the outer-to-inner velocity ratio is about 0.5. The theory also shows that the higher the outer-to-inner area ratio, the lower the forward-arc amplification due to flight. (Author)

**A79-29021 \* #** Unsteady airloads in supercritical transonic flows. M. H. Williams (Princeton University, Princeton, N.J.). In: *Structures, Structural Dynamics, and Materials Conference, 20th, St. Louis, Mo., April 4-6, 1979, Technical Papers on Structures and Materials. (A79-29002 11-39)* New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 185-191. 8 refs. Grant No. NSG-2194. (AIAA 79-0767)

Results obtained from a simplified theory of unsteady perturbations of supercritical two-dimensional transonic flows, introduced in an earlier paper, are presented. Unsteady loads generated by an oscillating flap and by airfoils oscillating as a whole are given with comparisons to experimental results and finite difference solutions. The theory, which was originally formulated for symmetric airfoils at zero mean angle of attack, is extended to treat asymmetric mean flows.

(Author)

**A79-29022 \* #** Experiments in unsteady transonic flow. S. S. Davis and G. N. Malcolm (NASA, Ames Research Center, Moffett Field, Calif.). In: *Structures, Structural Dynamics, and Materials Conference, 20th, St. Louis, Mo., April 4-6, 1979, Technical Papers on Structures and Materials. (A79-29002 11-39)* New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 192-208. 26 refs. (AIAA 79-0769)

The static and dynamic response of a 0.5-m-chord airfoil were measured in the NASA-Ames 11- by 11-Foot Transonic Wind Tunnel. The effects of mean angle of attack, Reynolds number, oscillation mode, and frequency were investigated over a range of subsonic and transonic Mach numbers. Unsteady pressure distributions and loads on an oscillating NACA 64A010 airfoil are discussed. The unsteady pressure distributions are compared with classical subsonic theory and with newer unsteady aerodynamic codes. The experimental data are also used to assess the validity of linearity and modal superposition in the transonic-flow regime. (Author)

**A79-29040 \* #** Investigation of flexible nozzle wall-flutter incidents in the NASA-Ames Research Center 11- by 11-foot transonic wind tunnel. L. L. Erickson, D. L. Kassner, L. R. Guist, and M. K. Chargin (NASA, Ames Research Center, Moffett Field, Calif.). In: *Structures, Structural Dynamics, and Materials Conference, 20th, St. Louis, Mo., April 4-6, 1979, Technical Papers on Structures and Materials. (A79-29002 11-39)* New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 360-382. 13 refs. (AIAA 79-0797)

Twice during the spring of 1978, the two steel-plate 'flex-walls' that form the variable-geometry nozzle of the 11-by 11-foot tunnel at Ames Research Center experienced a severe dynamic instability. Both walls fluttered in the fundamental beam-bending mode and experienced stresses approaching the yield strength of the material. Both flutter incidents occurred at Mach numbers of about 1.15. The tunnel, operational for 24 years, had no history of such an instability. The cause of these flutter incidents, the steps taken to prevent a recurrence, and the requalification of the facility are described.

(Author)

A79-2R044 \* # Analytical aspects of Randomdec analysis. R. E. Reed (Nielsen Engineering and Research, Inc., Mountain View, Calif.). In: Structures, Structural Dynamics, and Materials Conference, 20th, St. Louis, Mo., April 4-6, 1979, Technical Papers on Structures and Materials. (A79-2R002 11-39) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 404-409. Contract No. NAS2-8702. (AIAA 79-0828)

Relationships between Randomdec analysis and conventional methods of analysis such as Fourier and modal analysis are shown. The Randomdec signature is described in terms of the Fourier amplitude coefficients. Using this result, the effect of filtering the time history is shown. For a linear, two mode model, signatures are compared to the free response of the system subjected to different initial conditions to show the relationship of displacement and acceleration signatures to the physical system. Detection and location of flaws is also discussed.

(Author)

A79-30482 \* # Aircraft wake flow effect and horizontal tail buffet. C. Hwang and W. S. Pi (Northrop Corp., Hawthorne, Calif.). *Journal of Aircraft*, vol. 16, Apr. 1979, p. 282-284. Contract No. NAS2-8734.

As part of a program to investigate the fluctuating pressure distribution and response behavior of a fighter aircraft in transonic maneuver, an F-5A scale model has previously been tested in an 11-ft transonic wind tunnel. The model, with a number of static and dynamic pressure transducers imbedded in the lifting surfaces was tested at various angles of attack up to 16 deg. In this paper, test results of particular interest to wake flow and horizontal tail buffet are described. It is shown that the dynamic pressure data on the tail surface at the specified flight conditions serve to determine the local dynamic loads. They also influence the control performance of the aircraft under maneuver conditions where buffet is encountered. The data presented demonstrate a number of contributing factors that affect the tail dynamic pressures in the transonic regime.

S.D.

A79-31342 \* Non-linear dynamic response of a wind turbine blade. I. Chopra (NASA, Ames Research Center, Moffett Field, Calif.; MIT, Cambridge, Mass.) and J. Dugundji (MIT, Cambridge, Mass.). *Journal of Sound and Vibration*, vol. 63, Mar. 22, 1979, p. 265-286. 17 refs.

The paper outlines the nonlinear dynamic analysis of an isolated three-degree flap-lag-feather wind turbine blade under a gravity field and with shear flow. Lagrangian equations are used to derive the nonlinear equations of motion of blade for arbitrarily large angular deflections. The limit cycle analysis for forced oscillations and the determination of the principal parametric resonance of the blade due to periodic forces from the gravity field and wind shear are performed using the harmonic balance method. Results are obtained first for a two-degree flap-lag blade, then the effect of the third degree of freedom (feather) is studied. The self-excited flutter solutions are obtained for a uniform wind and with gravity forces neglected. The effects of several parameters on the blade stability are examined, including coning angle, structural damping, Lock number, and feather frequency. The limit cycle flutter solution of a typical configuration shows a substantial nonlinear softening spring behavior.

S.D.

A79-34251 \* An algebraic structure of discrete-time biaffine systems. T.-J. Tarn (Washington University, St. Louis, Mo.) and S. Nonoyama (NASA, Ames Research Center, Moffett Field, Calif.). *IEEE Transactions on Automatic Control*, vol. AC-24, Apr. 1979, p. 211-221. 21 refs. NSF Grants No. ENG-76-80365-A01; No. Eng-75-09755; No. INT-76-17175.

New results on the realization of finite-dimensional, discrete-time, internally biaffine systems are presented in this paper. The external behavior of such systems is described by multiaffine functions and the state space is constructed via Nerode equivalence relations. We prove that the state space is an affine space. An algorithm which amounts to choosing a frame for the affine space is presented. Our algorithm reduces in the linear and bilinear case to a generalization of algorithms existing in the literature. Explicit existence criteria for span-canonical realizations as well as an affine isomorphism theorem are given.

(Author)

F

A79-34520 \* # A rationale for human operator pulsive control behavior. R. A. Hess (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Guidance and Control*, vol. 2, May-June 1979, p. 221-227. 12 refs.

When performing tracking tasks which involve demanding controlled elements such as those with K/s-squared dynamics, the human operator often develops discrete or pulsive control outputs. A dual-loop model of the human operator is discussed, the dominant adaptive feature of which is the explicit appearance of an internal model of the manipulator-controlled element dynamics in an inner feedback loop. Using this model, a rationale for pulsive control behavior is offered which is based upon the assumption that the human attempts to reduce the computational burden associated with time integration of sensory inputs. It is shown that such time integration is a natural consequence of having an internal representation of the K/s-squared-controlled element dynamics in the dual-loop model. A digital simulation is discussed in which a modified form of the dual-loop model is shown to be capable of producing pulsive control behavior qualitatively comparable to that obtained in experiment.

(Author)

A79-36709 \* A Demonstration Advanced Avionics System for general aviation. D. G. Denery, G. P. Callas, C. T. Jackson, B. K. Berkstresser, and G. H. Hardy (NASA, Ames Research Center, Moffett Field, Calif.). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition*, Wichita, Kan., Apr. 3-6, 1979, Paper 790569. 11 p.

A program initiated within NASA has emphasized the use of a data bus, microprocessors, electronic displays and data entry devices

for general aviation. A Demonstration Advanced Avionics System (DAAS) capable of evaluating critical and promising elements of an integrating system that will perform the functions of (1) automated guidance and navigation; (2) flight planning; (3) weight and balance performance computations; (4) monitoring and warning; and (5) storage of normal and emergency check lists and operational limitations is described. Consideration is given to two major parts of the DAAS instrument panel: the integrated data control center and an electronic horizontal situation indicator, and to the system architecture. The system is to be installed in the Ames Research Center's Cessna 402B in the latter part of 1980; engineering flight testing will begin in the first part of 1981. V.T.

**A79-36733 \*** Application of split-film anemometer and mini-computer for measurement in turbulent separated flow. W. H. Wentz, T. Habluetzel (Wichita State University, Wichita, Kan.), D. C. Howe (Gates Learjet Corp., Wichita, Kan.), and K. A. Fiscko (U.S. Army, Washington, D.C.). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, Kan., Apr. 3-6, 1979, Paper 790601*. 10 p. Grants No. NGR-17-003-021; No. NSG-2134.

A split-film anemometer has been adapted for measurement of highly turbulent intermittently reversing flows in regions of local separation around airfoils and flaps. Analog signals from the split-film anemometer are fed directly to a mini-computer for processing and analysis. Mean velocity magnitude and direction, intermittency of reversal, turbulence intensity and histograms of the velocity are obtained as outputs of the system. (Author)

**A79-38135 \* #** Some observations on the mechanism of aircraft wing rock. C. Hwang and W. S. Pi (Northrop Corp., Aircraft Group, Hawthorne, Calif.). *Journal of Aircraft*, vol. 16, June 1979, p. 366-373. 6 refs. Contract No. NAS2-8734.

A scale model of the Northrop F-5A was tested in NASA Ames Research Center Eleven-Foot Transonic Tunnel to simulate the wing rock oscillations in a transonic maneuver. For this purpose, a flexible model support device was designed and fabricated, which allowed the model to oscillate in roll at the scaled wing rock frequency. Two tunnel entries were performed to acquire the pressure (steady state and fluctuating) and response data when the model was held fixed and when it was excited by flow to oscillate in roll. Based on these data, a limit cycle mechanism was identified, which supplied energy to the aircraft model and caused the Dutch roll type oscillations, commonly called wing rock. The major origin of the fluctuating pressures that contributed to the limit cycle was traced to the wing surface leading edge stall and the subsequent lift recovery. For typical wing rock oscillations, the energy balance between the pressure work input and the energy consumed by the model's aerodynamic and mechanical damping was formulated and numerical data presented. (Author)

**A79-38393 \*** Effects of forward velocity on sound radiation from convecting monopole and dipole sources in jet flow. R. Dash (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Sound and Vibration*, vol. 64, May 22, 1979, p. 187-207. 26 refs.

A theoretical model is presented of the effects of forward velocity of an aircraft at arbitrary subsonic speed on sound radiated from convecting monopole and dipole sources embedded in the jet flow. It is found that with increasing forward velocity there is a steadily increasing amplification (over the static case) of the sound radiated into the forward arc and a large reduction of the sound which is radiated into the rearward arc. The same trend is also shown to result when there is a reduction in the exhaust velocity, with, however, a further rise in amplification in the forward quadrant and a drop in attenuation in the aft quadrant. B.J.

**A79-38882 \*** Exploring team avionics systems by simulation. G. A. Brent and T. M. McCalla, Jr. (Southern Illinois University, Carbondale, Ill.). In: *Annual Simulation Symposium, 11th, Tampa, Fla., March 15-17, 1978, Record of Proceedings*. (A79-38876 16-59) Tampa, Fla., Annual Simulation Symposium; Long Beach, Calif., IEEE Computer Society, 1978, p. 155-170. 12 refs. Grant No. NSG-2238.

Configurations of software and hardware in a no-critical-element team architecture are under study for future general aviation aircraft avionics. The team integrated avionics system, based on microprocessors, can monitor and partially interpret all flight instrument data, engine parameters, and navigation information faster than a human pilot. Simulation programs based on an event-oriented simulation language are being used to design team architectures. J.M.B.

**A79-38910 \* #** An elliptic representation of coupled boundary layers and inviscid core for computation of separated internal flows. S. Ghose (Stanford University, Stanford, Calif.). In: *Turbulent boundary layers: Forced, incompressible, non-reacting: Proceedings of the Joint Applied Mechanics, Fluids Engineering and Bioengineering Conference, Niagara Falls, N.Y., June 18-20, 1979*. (A79-38901 16-34) New York, American Society of Mechanical Engineers, 1979, p. 85-92. 9 refs. Grant No. NSG-2233.

This report presents a viscous-inviscid calculation method for the prediction of turbulent incompressible flows in diffusers with small regions of stall. Integral turbulent boundary layer equations (BLE) are used to provide boundary conditions for a finite difference representation of the inviscid core. The BLE are applied at the floating displacement-thickness line, resulting in a simultaneous set of nonlinear block tridiagonal equations which are solved iteratively using a successive line-relaxation technique. Results of the method have been applied to calculate the performance of a variety of asymmetric stalled diffusers. (Author)

**A79-38961 \* #** Evaluation of methods for prediction of propulsion system drag. G. D. Kuhn, O. J. McMillan, S. C. Perkins, Jr. (Nielsen Engineering and Research, Inc., Mountain View, Calif.), and E. W. Perkins. *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1148*. 13 p. 40 refs. Contract No. NAS2-9513.

The results of a study directed toward compilation of a theoretical and experimental data base covering inlet/airframe and nozzle/afterbody integration are described, with the major emphasis on the evaluation of the adequacy for preliminary design purposes of the data base for afterbody/propulsion system interference effects. Prediction methods that exist for afterbody/airframe interference effects are evaluated with respect to the requirements of breadth, ease of application and accuracy that are important for preliminary design. (Author)

**A79-39499 \*** Laser Doppler anemometer diagnostics in unsteady flows. K. L. Orloff (NASA, Ames Research Center, Moffett Field, Calif.). In: *Dynamic measurements in unsteady flows: Proceedings of the Dynamic Flow Conference, Marseille, France, September 11-14, 1978 and Baltimore, Md., September 18-21, 1978*. (A79-39476 16-35) Skovlunde, Denmark, Proceedings of the Dynamic Flow Conference 1978, 1979, p. 511-534. 34 refs.

The application of the laser Doppler anemometer (LDA) to unsteady flows is discussed with respect to necessary features of the signal processor, properties of the optical system, and the character of the flow under investigation. The discussion of signal processors includes consideration of frequency trackers, counter-type processors, particle properties, data rates, and statistics. Secondly, diffraction limitations for an optical system are viewed with respect to spatial resolution. Finally, the total velocity field is decomposed into its subfields and the feasibility of, criteria for, and possible types of conditional sampling are defined. Several reported LDA experiments using conditional sampling are presented to demonstrate the different techniques that may be used. (Author)

**A79-40480 \* #** Evaluation of turbo-propulsion simulators as a testing technique for fighter aircraft. R. O. Bailey, M. Harper (NASA, Ames Research Center, Moffett Field, Calif.), and T. Jannetta (NASA, Ames Research Center, Moffett Field, Calif.; McDonnell Aircraft Co., St. Louis, Mo.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1149.* 17 p. 13 refs.

Ames Research Center has under way a program to develop the technology for using turbine-powered jet engine simulators as a test technique for simulating installed jet engine characteristics in small-scale wind-tunnel models of complete VSTOL fighter configurations. The program consists of three key elements: (1) static testing SN003 prototype turbine engine simulator (MAPS), (2) the development of the Propulsion Simulator Calibration Laboratory at Ames, and (3) the design, fabrication, and testing of a twin-engine 'closely coupled' V/STOL fighter wind-tunnel model. The model will use the Compact Multi-mission Propulsion Simulator (CMAPS) and will also be tested in flow-through and jet-effects modes to assess the effect of simultaneous inlet and nozzle flow simulation. This paper includes a description of the planned effort and anticipated future tasks. (Author)

**A79-40760 \* #** Design and performance of the propulsion system for the quiet short-haul research aircraft /QSRA/. M. D. Shovlin (NASA, Ames Research Center, Moffett Field, Calif.), H. Skavdahl, and D. L. Harkonen (Boeing Commercial Airplane Co., Seattle, Wash.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1313.* 10 p. 6 refs.

This paper describes the design and performance of the Quiet Short-Haul Research Aircraft (QSRA) propulsion system. A discussion of the mixed-flow boundary layer control (BLC) system, which uses high and low pressure engine bleed air, is included. This system seriously affected propulsion system performance, particularly engine acceleration characteristics, requiring an integration of BLC system and powerplant controls. Funding limitations for the QSRA Project prevented extensive full-scale testing and systems mockups, resulting in a high reliance on small-scale tests and analytical techniques. Ground tests of the actual aircraft systems showed that the extrapolation of small-scale tests and analytical techniques were in good agreement with measured full-scale results. (Author)

**A79-41133 \*** A multiloop generalization of the circle stability criterion. M. G. Safonov (Southern California, University, Los Angeles, Calif.) and M. Athans (MIT, Cambridge, Mass.). In: Annual Asilomar Conference on Circuits, Systems, and Computers, 12th, Pacific Grove, Calif., November 6-8, 1978, Conference Record. (A79-41102 17-59) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 417-421. 22 refs. NSF Grant No. ENG-78-05628; Grants No. NGL-22-009-124; No. NsG-1312; Contract No. F44620-76-C-0061.

A frequency-domain stability criterion is presented, generalizing the well-known circle stability criterion to multiloop feedback systems having bounded nonlinearity, parameter variations, and/or frequency-dependent ignorance of component dynamics. Unlike previous generalizations, the theory is not restricted to weakly-coupled, diagonally dominant or nearly normal systems. Potential applications include the analysis of feedback system integrity and multiloop feedback system stability margins. (Author)

**A79-42059 \*** Turbulent density fluctuations in a subsonic and transonic free jet using crossed-beam schlieren techniques. R. A. Martin (NASA, Ames Research Center, Moffett Field, Calif.). In: Biennial Symposium on Turbulence, 5th, Rolla, Mo., October 3-5, 1977, Proceedings. (A79-42026 17-34) Princeton, N.J., Science Press, 1979, p. 411-425. 16 refs.

Scalar density fluctuations were measured nonintrusively in the shear layer of a 5.08-cm (2-in.) cold air jet using a crossed-beam

schlieren method. Two statistics, covariance and three-dimensional spectrum function, were estimated for an exit Mach number range of 0.3 to 0.97. The density fluctuation intensity, integral scale, and eddy convection speed were calculated and compared to available data where possible. Spectra were found to change significantly in shape becoming less peaked between 3 and 9 jet diameters downstream from the orifice, but they consistently exhibited a -5/3 power law decay at 3, 6, and 9 diameters for frequencies above the peak. (Author)

**A79-42800 \* #** Simulation study of the operational effects of fuel-conservative approaches. L. Tobias, E. A. Palmer (NASA, Ames Research Center, Moffett Field, Calif.), and P. J. O'Brien (FAA, National Aviation Facilities Experimental Center, Atlantic City, N.J.). *Journal of Aircraft*, vol. 16, July 1979, p. 498-505. 5 refs.

Fuel-conservative procedures have been investigated using real-time air traffic control simulations linked to two piloted simulators. The fuel-conservative procedures studied were profile descents and two types of landing approaches, delayed flap and IATA. The investigation determined the effect of these procedures on the ATC system operation. It examined the mixing of aircraft executing fuel-conservative approaches with those executing conventional approaches. The most difficult approach type mix of traffic was found to be 50% conventional and 50% delayed flap. However, for the test scenario chosen, arrival rates of at least 30 aircraft per hour were feasible and resulted in a net average fuel saving, even for the most difficult mix. Also, there is a fuel savings and reduced controller workload for the profile descent procedures. (Author)

**A79-43023 \*** Relativistic L-shell Auger and Coster-Kronig rates and fluorescence yields. M. H. Chen, E. Laiman, B. Crasemann (Oregon, University, Eugene, Ore.), M. Aoyagi (NASA, Ames Research Center, Moffett Field, Calif.), and H. Mark (USAF, Washington, D.C.). *Physical Review A - General Physics, 3rd Series*, vol. 19, June 1979, p. 2253-2259. 31 refs. Grants No. DAAG-29-78-G-100; No. NGR-38-003-036; No. AF-AFOSR-79-0026.

Relativistic calculations of radiationless transition rates to L-subshell vacancy states in selected atoms with Z in the 70-96 range have been performed. The Auger and Coster-Kronig transition probabilities are calculated from perturbation theory, assuming frozen orbitals, in the Dirac-Hartree-Slater approach. Transition rates, fluorescence yields, and Coster-Kronig yields are compared with nonrelativistic theoretical results and with experiment. Relativity is found to affect the L-subshell Auger widths by (10-25)% and individual transition rates to certain j-j configurations by as much as 40% at Z = 80. The widths of L sub i vacancy states and the L sub 2 Coster-Kronig yields f33 from these relativistic calculations agree much better with experiment than earlier nonrelativistic theoretical values. (Author)

**A79-45333 \*** Computation of subsonic and transonic flow about lifting rotor blades. R. Arieli and M. E. Tauber (NASA, Ames Research Center, Moffett Field, Calif.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. (A79-45302 19-01) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 314-323. 9 refs. (AIAA 79-1667)

An inviscid, nonconservative, three-dimensional potential flow code has been developed for computing the quasi-steady flow about an isolated lifting rotor blade. Calculations from the code were compared with chordwise pressure measurements obtained in a wind tunnel on a nonlifting rotor at transonic tip speeds at advance ratios from 0.40 to 0.55. The overall agreement between theoretical calculations and experiment was good. To illustrate the early capability of the program, the flow about a hypothetical lifting rotor blade having twist, airfoil thickness taper, and a 20 deg sweptback tip was analyzed at azimuthal positions of 60, 90, and 120 deg for an advance ratio of 0.342. A typical run on a CDC 7600 computer required about 5 min for one rotor position at transonic tip speeds. (Author)

**A79-45345 \* # A review of helicopter control-display requirements for decelerating instrument approach.** J. V. Lebacqz (NASA, Ames Research Center, Moffett Field, Calif.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. (A79-45302 19-01) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 426-439. 57 refs. (AIAA 79-1683)

This paper reviews research and operational test programs that have dealt with control and display requirements for helicopters performing decelerating approaches in the terminal area under instrument flight conditions. A survey of literature concentrating on flight programs resulted in approximately 50 applicable references which were summarized and classified according to the type of stability/control augmentation that was emphasized. On this basis, display information requirements for each control system type were hypothesized consistent with documented results of these programs. Nine control-display combinations that appear to warrant further ground simulation and flight testing are defined and discussed.

(Author)

**A79-45362 \* # Evaluation of the navigation performance of shipboard-VTOL-landing guidance systems.** L. A. McGee, C. H. Paulk, Jr., S. A. Steck (NASA, Ames Research Center, Moffett Field, Calif.), S. F. Schmidt, and A. W. Merz (Analytical Mechanics Associates, Inc., Mountain View, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. (A79-45351 19-12) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 101-113. (AIAA 79-1708)

The objective of this study was to explore the performance of a VTOL aircraft landing approach navigation system that receives data (1) from either a microwave scanning beam (MSB) or a radar-transponder (R-T) landing guidance system, and (2) information data-linked from an aviation facility ship. State-of-the-art low-cost-aided inertial techniques and variable gain filters were used in the assumed navigation system. Compensation for ship motion was accomplished by a landing pad deviation vector concept that is a measure of the landing pad's deviation from its calm sea location. The results show that the landing guidance concepts were successful in meeting all of the current Navy navigation error specifications, provided that vector magnitude of the allowable error, rather than the error in each axis, is a permissible interpretation of acceptable performance. The success of these concepts, however, is strongly dependent on the distance measuring equipment bias. In addition, the 'best possible' closed-loop tracking performance achievable with the assumed point-mass VTOL aircraft guidance concept is demonstrated.

(Author)

**A79-45363 \* # Fuel-conservative guidance system for powered-lift aircraft.** H. Erzberger and J. D. McLean (NASA, Ames Research Center, Moffett Field, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. (A79-45351 19-12) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 114-128. 9 refs. (AIAA 79-1709)

A concept for automatic terminal-area guidance, comprising two modes of operation, has been developed and evaluated in flight tests. In the first or predictive mode, fuel-efficient approach trajectories are synthesized in fast time. In the second or tracking mode, the synthesized trajectories are reconstructed and tracked automatically. An energy rate performance model derived from the lift, drag, and propulsion-system characteristics of the aircraft is used in the synthesis algorithm. The method optimizes the trajectory for the initial aircraft position and wind and temperature profiles encountered during each landing approach. The paper describes the design theory and discusses the results of simulations and flight tests using the Augmentor Wing Jet STOL Research Aircraft. (Author)

**A79-45411 \* # A structural model of the adaptive human pilot.** R. A. Hess (NASA, Ames Research Center, Moffett Field, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. (A79-45351 19-12) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 573-583. 25 refs. (AIAA 79-1784)

A compensatory tracking model of the human pilot is offered which attempts to provide a more realistic representation of the human's signal processing structure than that which is exhibited by pilot models currently in use. Two features of the model distinguish it from other representations of the human pilot. First proprioceptive information from the control stick or manipulator constitutes one of the major feedback paths in the model, providing feedback of vehicle output rate due to control activity. Implicit in this feedback loop is a model of the vehicle dynamics which is valid in and beyond the region of crossover. Second, error-rate information is continuously derived and independently but intermittently controlled. An output injected remnant model is offered and qualitatively justified on the basis of providing a measure of the effect of inaccuracies such as time variations in the pilot's internal model of the controlled element dynamics. The data from experimental tracking tasks involving five different controlled element dynamics and one nonideal viewing condition were matched with model generated describing functions and remnant power spectral densities. (Author)

**A79-45413 \* # A piloted simulator investigation of helicopter precision decelerating approaches to hover to determine single-pilot IFR /SPIFR/ requirements.** A. V. Phatak (Analytical Mechanics Associates, Inc., Mountain View, Calif.), L. L. Peach, Jr., R. A. Hess, V. L. Ross, G. W. Hall, and R. M. Gerdes (NASA, Ames Research Center, Moffett Field, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. (A79-45351 19-12) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 594-608. 10 refs. (AIAA 79-1886)

The results of single-pilot instrument flight rules (SPIFR) experiments conducted on the NASA-Ames V/STOLAND simulator are presented. Several factors having a significant impact on requirements for helicopter SPIFR decelerating, steep approaches to landing are considered: (1) approach weather conditions, (2) flight path geometry, (3) deceleration guidance law, (4) level of stability and command augmentation, (5) cockpit display sophistication, (6) accuracy of navigation aids, and (7) helipad lighting and visual aids. Particular emphasis is placed on the relative effects of deceleration profile, control augmentation, and flight director parameters on pilot performance, workload, and opinion rating. Problems associated with the development of a pilot acceptance analytical methodology are outlined.

V.T.

**A79-46682 \* # A study of viscous cross-flow effects on circular cylinders at high Reynolds numbers.** W. D. James (Iowa State University of Science and Technology, Ames, Iowa), S. W. Paris (Boeing Aerospace Co., Seattle, Wash.), and G. N. Malcolm (NASA, Ames Research Center, Moffett Field, Calif.). American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1477. 15 p. 15 refs. Grant No. NSG-2091.

Results of experimental studies on viscous cross-flow over circular cylinders for Reynolds numbers from  $0.15 \times 10^6$  to the 6th to  $10.9 \times 10^6$  to the 6th at Mach numbers of less than 0.3 are presented and compared with previous work where possible. Results presented include the variation of static cross-flow drag coefficients with both Reynolds number and ratio of surface roughness to model diameter, the variation of Strouhal number with Reynolds number and the dynamic variation of surface static pressure coefficients with both angular position around the cylinder and Reynolds number. The effects of end plates on flow around two-dimensional bluff-bodies and of tunnel blockage on drag measurements are also discussed.

(Author)

A79-46684 \* # An investigation of transonic turbulent boundary layer separation generated on an axisymmetric flow model. W. D. Bachalo (Spectron Development Laboratories, Inc., Costa Mesa, Calif.) and D. A. Johnson (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1479.* 14 p. 17 refs.

Experimental data are presented describing the transonic turbulent separated flow generated by an axisymmetric flow model. The model consisted of a circular-arc bump affixed to a straight circular cylinder aligned with the flow direction. Measurements of the mean velocity, turbulence intensity, and Reynolds shear stress profiles were made in the separated flow. These data revealed the dramatic changes in the shear stress levels as the flow passed from the interaction through to reattachment. Information on the behavior of the turbulence reaction to the imposed pressure gradients, as presented in this investigation, will be required for the development of the turbulence models used in predicting nonequilibrium turbulent flow fields. (Author)

A79-46694 \* # Transonic flow past a symmetrical airfoil at high angle of attack. D. A. Johnson, F. K. Owen (NASA, Ames Research Center, Moffett Field, Calif.), and W. D. Bachalo (NASA, Ames Research Center, Moffett Field; Spectron Development Laboratories, Inc., Costa Mesa, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1500.* 15 p. 21 refs.

The results of an experimental investigation of shock-induced stall and leading-edge stall on a 64A010 airfoil section are presented. Advanced nonintrusive techniques - laser velocimetry, holographic interferometry, and buried-wire anemometry - were used in characterizing the inviscid and viscous flow regions. The measurements include Mach contours of the inviscid flow regions, and mean velocity, flow direction and Reynolds shear stress profiles in the separated regions. The experimental observations of this study are relevant to efforts to improve surface pressure prediction methods for airfoils at or near stall. (Author)

A79-46715 \* # Effect of viscosity on wind-tunnel wall interference for airfoils at high lift. L. E. Olson (NASA, Ames Research Center, Moffett Field, Calif.) and S. Stridsberg (Flygtekniska Forsoksanstalten, Bromma, Sweden). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1534.* 7 p. 21 refs.

The effect of the walls of a wind tunnel on the subsonic, two-dimensional flow past airfoils at high angles of attack is studied theoretically and experimentally. The computerized analysis, which is based on iteratively coupled potential-flow, boundary-layer, and separated-flow analyses, includes determining the effect of viscosity and flow separation on the airfoil/wall interaction. Predictions of the effects of wind-tunnel wall on the lift of airfoils are compared with wall corrections based on inviscid image analyses, and with experimental data. These comparisons are made for airfoils that are large relative to the size of the test section of the wind tunnel. It is shown that the inviscid image modeling of the wind-tunnel interaction becomes inaccurate at lift coefficients near maximum lift or when the airfoil/wall interaction is particularly strong. It is also shown that the present method of analysis (which includes boundary-layer and flow-separation effects) will provide accurate wind-tunnel wall corrections for lift coefficients up to maximum lift. (Author)

A79-47476 \* L-shell Auger and Coster-Kronig spectra from relativistic theory. M. H. Chen, B. Crasemann (Oregon University, Eugene, Ore.), M. Aoyagi (NASA, Ames Research Center, Moffett Field, Calif.), and H. Mark (USAF, Washington, D.C.). *Physical Review A - General Physics, 3rd Series, vol. 20, Aug. 1979, p.*

385-393. 18 refs. Grants No. DAAG29-78-G-0010; No. NGR-38-003-036; No. AF-AFOSR-79-0026.

The intensities of L-shell Auger and Coster-Kronig transitions in heavy atoms have been calculated relativistically. A detailed comparison is made with measured Auger spectra of Pt and U. The pertinent transition energies were computed from relativistic wave functions with inclusion of the Breit interaction, self-energy, a vacuum-polarization correction, and complete atomic relaxation. Multiple splitting is found to distribute Auger electrons from certain transitions among several lines. The analysis leads to reassignment of a number of lines in the measured spectra. Lines originally identified as L2-L3Ni in the U spectrum are shown to arise from M4,5 Auger transitions instead. (Author)

A79-47608 \* Recent V/STOL aircraft designs. W. H. Deckert (NASA, Ames Research Center, V/STOL Aircraft Technology Div., Moffett Field, Calif.). *American Helicopter Society, Journal, vol. 24, June 1979, p. 30-37.*

The paper reviews the V/STOL aircraft designs pursued by industry from 1971 to 1978, with emphasis on the 1975-1978 period. Consideration is given to those designs pertaining to vertical-altitude and horizontal-altitude V/STOL types. These are divided into such concepts as tilting jet engine, lift/cruise engine, lift engine, lift/cruise fan, ejector augmentor, tilt rotor, stowed rotor, and rotor wing. B.J.

A79-47900 \* # Full-scale wind tunnel study of nacelle shape on cooling drag. V. R. Corsiglia, J. Katz (NASA, Ames Research Center, Moffett Field, Calif.), and R. A. Kroeger (Michigan University, Ann Arbor, Mich.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1820.* 10 p. 7 refs.

Tests were made in the NASA-Ames 40- by 80 Foot Wind Tunnel of a wing semispan with a nacelle (no propeller) from a typical, general aviation twin-engine aircraft. Measurements were made of the effect on drag of the cooling air flow through the nacelle. Internal and external nacelle pressures were measured. It was found that the cooling flow accounts for about 13% of the estimated airplane drag and about 42% of the cooling flow drag is associated with the internal flow. It was concluded that improvements could be made by relocating both the inlet and the outlet of the cooling air. (Author)

A79-47914 \* # Aerodynamic effects of an attitude control vane on a tilt-nacelle V/STOL propulsion system. M. D. Betzina (NASA, Ames Research Center, Moffett Field, Calif.) and R. Kita (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1855.* 11 p.

One possible technique for obtaining longitudinal control on a tilt-nacelle V/STOL aircraft is the use of a variable attitude vane assembly mounted in the propulsion system exhaust. Deflecting the vane produces large forces and moments without depending on forward speed of the aircraft. Tests are carried out in the Ames 40 by 80 ft wind tunnel on a large-scale tilt-nacelle V/STOL propulsion system with and without a variable attitude control vane assembly. Aerodynamic characteristics are analyzed in terms of nacelle aerodynamics, vane aerodynamics, and vane-induced effects on the nacelle aerodynamics. It is shown that the aerodynamic forces due to the nacelle without the vane can be a significant part of the total forces produced by the propulsion system. The control vane effectively produces large changes in pitching moment which are accompanied by significant changes in total lift and drag. The vane has a substantial effect on the propulsion-system aerodynamics. Other pertinent results are also given. S.D.

F

**A79-47934 \*** Towards fault-tolerant optimal control. H. J. Chizeck and A. S. Willsky (MIT, Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 19, 20. 6 refs. Contract No. N00014-77-C-0224; Grant No. NGL-22-009-124.

The paper considers the design of fault-tolerant controllers that may endow systems with dynamic reliability. Results for jump linear quadratic Gaussian control problems are extended to include random jump costs, trajectory discontinuities, and a simple case of non-Markovian mode transitions. B.J.

**A79-47952 \*** On stability theory. M. G. Safonov (Southern California, University, Los Angeles, Calif.) and M. Athans (MIT, Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 301-314. 15 refs. NSF Grant No. ENG-78-05628; Grants No. NGL-22-009-124; No. NSG-1312.

It is found that under mild assumptions, feedback system stability can be concluded if one can 'topologically separate' the infinite-dimensional function space containing the system's dynamical input-output relations into two regions, one region containing the dynamical input-output relation of the 'feedforward' element of the system and the other region containing the dynamical output-input relation of the 'feedback' element. Nonlinear system stability criteria of both the input-output type and the state-space (Liapunov) type are interpreted in this context. The abstract generality and conceptual simplicity afforded by the topological separation perspective clarifies some of the basic issues underlying stability theory and serves to suggest improvements in existing stability criteria. A generalization of Zames' (1966) conic-relation stability criterion is proved, laying the foundation for improved multivariable generalizations of the frequency-domain circle stability criterion for nonlinear systems. (Author)

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**A79-47983 \*** Minimum-variance fixed-form compensation of linear systems. T. L. Johnson (MIT, Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 828, 827. 14 refs. NSF Grant No. 76-02860; Grant No. NGL-22-009-124.

The problem of determining the linear time-invariant compensator of a specified dimension which minimizes the asymptotic expected value of a quadratic form in the state variables of a linear stochastic system of arbitrary order, is considered. It is shown that under appropriate assumptions, the solution of this problem can be interpreted as a minimum-order observer-based or dual observer-based compensator for an optimally aggregated model of the plant. (Author)

**A79-47992 \*** Time-varying linear systems and the theory of non-linear waves. R. Hermann (Harvard University, Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 991-996. 13 refs. NSF Grant No. MCS-78-06000; Grant No. NSG-2252.

The isospectral deformation of a Sturm-Liouville equation is extended to general linear time-varying systems and a method is described for determining the resulting nonlinear partial differential equations. Consideration is given to (1) isospectral deformation of I/O systems with boundary value conditions and (2) the spectral vector bundles attached to linear time-varying systems. B.J.

**A79-47993 \*** On certain families of rational functions arising in dynamics. C. I. Byrnes (Harvard University, Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1002-1006. 13 refs. Grant No. NSG-2265; Contract No. N00014-75-C-0648.

It is noted that linear systems, depending on parameters, can occur in diverse situations including families of rational solutions to the Korteweg-de Vries equation or to the finite Toda lattice. The inverse scattering method used by Moser (1975) to obtain canonical coordinates for the finite homogeneous Toda lattice can be used for the synthesis of RC networks. It is concluded that the multivariable RC setting is ideal for the analysis of the periodic Toda lattice. B.J.

**A79-47994 \*** Stochastic control and the second law of thermodynamics. R. W. Brockett (Harvard University, Cambridge, Mass.) and L. C. Willems (Groningen, Rijksuniversiteit, Groningen, Netherlands). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1007-1011. 6 refs. Grants No. DAAG29-76-C-0139; No. NSG-2265; Contract No. N00014-75-C-0648.

The second law of thermodynamics is studied from the point of view of stochastic control theory. We find that the feedback control laws which are of interest are those which depend only on average values, and not on sample path behavior. We are lead to a criterion which, when satisfied, permits one to assign a temperature to a stochastic system in such a way as to have Carnot cycles be the optimal trajectories of optimal control problems. Entropy is also defined and we are able to prove an equipartition of energy theorem using this definition of temperature. Our formulation allows one to treat irreversibility in a quite natural and completely precise way. (Author)

**A79-47995 \*** The geometry of the partial realization problem. R. W. Brockett and P. Hall (Harvard University, Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1048-1052. 7 refs. Grants No. DAAG29-76-C-0139; No. NSG-2265; Contract No. N00014-75-C-0648.

It is shown that the space of sequences of length  $n$  which have an extrapolation of McMillan degree  $k$ , and no extrapolations of lower McMillan degree can be given the structure of a differentiable manifold. This approach makes the proof of certain known results on the partial realization problem quite straightforward and makes it possible to establish some important new results as well. A key tool is the fact, proven here, that the set of  $n$  by  $r$  real Hankel matrices of rank  $r$  is a manifold with  $r+1$  connected components. (Author)

**A79-47996 \*** Feedback invariants for linear systems defined over rings. C. I. Byrnes (Harvard University, Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1053-1056. 12 refs. Grant No. NSG-2265.

A coefficient-assignability theorem is presented for systems defined over a commutative ring with 1. The conditions examined include all the general results on coefficient-assignability available in the literature. It is concluded that the proposed techniques are not effective for the case of the weaker property of pole placement when it is assumed that the commutative ring is a PID. Morse's well-known theorem seems to be the best result available for this situation. B.J.

**A79-49039 \*** Laser velocimetry and holographic interferometry measurements in transonic flows. W. D. Bachalo (Spectron Development Laboratories, Inc., Costa Mesa, Calif.) and D. A. Johnson (NASA, Ames Research Center, Moffett Field, Calif.). In: *Laser velocimetry and particle sizing: Proceedings of the Third International Workshop*, West Lafayette, Ind., July 11-13, 1978. (A79-49012 21-35) Washington, D.C., Hemisphere Publishing Corp., 1979, p. 369-381. 7 refs. NASA-supported research.

Measurements of the transonic flow about a two-dimensional airfoil have been made with holographic interferometry and laser velocimetry. Quantitative data obtained with the interferometer are compared to the laser velocimeter and surface pressure measurements to evaluate the accuracy of the technique. Good agreement in the results confirmed the two-dimensionality of the flow and the potential of the interferometer in making unsteady transonic flow measurements in the future. (Author)

**A79-49054 \* #** Effect of tip shape on blade loading characteristics for a two-bladed rotor in hover. J. D. Ballard, K. L. Orloff (NASA, Ames Research Center, Moffett Field, Calif.), and A. B. Luebs (Gates Learjet Corp., Wichita, Kan.). In: *American Helicopter Society, Annual National Forum*, 35th, Washington, D.C., May 21-23, 1979, Proceedings. (A79-49053 21-01) Washington, D.C., American Helicopter Society, 1979, 9 p. 14 refs. (AHS 79-1)

A laser velocimeter has been used to study the flow surrounding a 2.13-m-diameter, two-bladed, teetering model-scale helicopter rotor operating in the hover condition. The rotor system employed interchangeable blade tips over the outer 25% radius. A conventional rectangular planform and an experimental ogee tip shape were studied. The radial distribution of the blade circulation was obtained by measuring the velocity tangent to a closed rectangular contour around the airfoil section at a number of radial locations. A relationship between local circulation and bound vorticity is invoked to obtain the radial variations in the sectional lifting properties of the blade. The tip vortex-induced velocity was also measured immediately behind the generating blade and immediately before the encounter with the following blade. The mutual influences between blade loading, shed vorticity, and the structure of the encountered vortex are quantified by the results presented and are discussed comparatively for the rectangular and ogee planforms. The experimental loading for the rectangular tip is also compared with predictions of existing rotor analysis. (Author)

**A79-49078 \* #** Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight. R. D. Forrest (FAA, Washington, D.C.), R. T. N. Chen, R. M. Gerdes, T. S. Alderete, and D. R. Gee (NASA, Ames Research Center, Moffett Field, Calif.). In: *American Helicopter Society, Annual National Forum*, 35th, Washington, D.C., May 21-23, 1979, Proceedings. (A79-49053 21-01) Washington, D.C., American Helicopter Society, 1979, 27 p. 12 refs. (AHS 79-26)

An exploratory piloted simulation was conducted to investigate the effects of the characteristics of helicopter flight control systems on instrument flight handling qualities. This joint FAA/NASA study was motivated by the need to improve instrument flight capability. A near-term objective is to assist in updating the airworthiness criteria for helicopter instrument flight. The experiment consisted of variations of single-rotor helicopter types and levels of stability and control augmentation systems (SCAS). These configurations were evaluated during an omnirange approach task under visual and instrument flight conditions. The levels of SCAS design included a simple rate damping system, collective decoupling plus rate damping, and an attitude command system with collective decoupling. A limited evaluation of stick force versus airspeed stability was accomplished. Some problems were experienced with control system mechanization which had a detrimental effect on longitudinal stability. Pilot ratings, pilot commentary, and performance data related to the task are presented. (Author)

**A79-49104 \* #** Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar. J. S.

Bull, D. M. Hegarty, J. D. Phillips, W. R. Sturgeon (NASA, Ames Research Center, Moffett Field Calif.), A. W. Hunting, and D. P. Pate (FAA, Flight Standards National Field Office, Oklahoma City, Okla.). In: *American Helicopter Society, Annual National Forum*, 35th, Washington, D.C., May 21-23, 1979, Proceedings. (A79-49053 21-01) Washington, D.C., American Helicopter Society, 1979, 10 p. (AHS 79-52)

Airborne weather and mapping radar is a near-term, economical method of providing 'self-contained' navigation information for approaches to offshore oil rigs and its use has been rapidly expanding in recent years. A joint NASA/FAA flight test investigation of helicopter IFR approaches to offshore oil rigs in the Gulf of Mexico was initiated in June 1978 and conducted under contract to Air Logistics. Approximately 120 approaches were flown in a Bell 212 helicopter by 15 operational pilots during the months of August and September 1978. The purpose of the tests was to collect data to (1) support development of advanced radar flight director concepts by NASA and (2) aid the establishment of Terminal Instrument Procedures (TERPS) criteria by the FAA. The flight test objectives were to develop airborne radar approach procedures, measure tracking errors, determine acceptable weather minimums, and determine pilot acceptability. Data obtained will contribute significantly to improved helicopter airborne radar approach capability and to the support of exploration, development, and utilization of the Nation's offshore oil supplies. (Author)

**A79-49105 \*** Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft. R. L. Marr, S. Blackman (Bell Helicopter Textron, Fort Worth, Tex.), J. A. Weiberg (NASA, Ames Research Center, Moffett Field, Calif.), and L. G. Schroers (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: *American Helicopter Society, Annual National Forum*, 35th, Washington, D.C., May 21-23, 1979, Proceedings. (A79-49053 21-01) Washington, D.C., American Helicopter Society, 1979, 12 p. (AHS 79-54)

The XV-15 Tilt Rotor Research Aircraft Project involves design, fabrication, and flight testing of two aircraft. This program is currently in the test phase for concept evaluation and substantiation of design. As part of this evaluation, one of the aircraft was tested in the NASA-Ames 40- by 80-foot wind tunnel. The status of testing to date and some of the results of the wind tunnel and flight tests are presented. (Author)

**A79-49336 \* #** XV-15 flight test results compared with design goals. K. G. Wernicke (Bell Helicopter Textron, Fort Worth, Tex.) and J. P. Magee (NASA, Ames Research Center; U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting*, New York, N.Y., Aug. 20-22, 1979, Paper 79-1839. 11 p. 10 refs.

Aircraft No. 2 is presently in the midst of flight envelope expansion. Noise and safety design goals have been demonstrated; preliminary results indicate that performance and component life goals may also be met. Hovering power indicates a standard hover ceiling of 7,000 feet. After 18.0 hours of flight, a true airspeed of 207 knots has been reached. The goal is a 300-knot cruise speed. So far, XV-15 flight tests indicate no reason why the tilt rotor concept should not fulfill its promise to provide a major step forward in air vehicle flexibility and in rotary wing performance. (Author)

**A79-49339 \* #** Effect of nozzle spacing on ground interference forces for a two jet V/STOL aircraft. W. G. Hill, Jr. and R. C. Jenkins (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting*, New York, N.Y., Aug. 20-22, 1979, Paper 79-1856. 13 p. 20 refs. Contract No. NAS2-10097.

The effect of nozzle spacing on ground interference forces was investigated for a two jet V/STOL aircraft design. The need for

information on the effect of jet spacing arises because of the tradeoff between mechanical complexity, which calls for close spacing, and roll control moments, which call for wider spacing. The ground interference forces on a two jet V/STOL aircraft model were measured for a range of nozzle spacings. Interference forces showed a complicated behavior with nozzle spacing, fuselage geometry, and height above ground. For some conditions a slight change in nozzle spacing resulted in a fourfold change in the interference force from 3% to 12% of the basic jet thrust. An understanding of the observed aircraft force behavior was developed using detailed measurements of the upwash flow properties, along with force and pressure measurements on a series of two dimensional fuselage representations.

(Author)

**A79-49869 \* #** Linearization of the boundary-layer equations of the minimum time-to-climb problem. M. D. Ardema (NASA, Ames Research Center, V/STOL Systems Office, Moffett Field, Calif.). *Journal of Guidance and Control*, vol. 2, Sept.-Oct. 1979, p. 434-436, 6 refs.

Ardema (1974) has formally linearized the two-point boundary value problem arising from a general optimal control problem, and has reviewed the known stability properties of such a linear system. In the present paper, Ardema's results are applied to the minimum time-to-climb problem. The linearized zeroth-order boundary layer equations of the problem are derived and solved. V.P.

**A79-50432 \*** Estimation of longitudinal aircraft characteristics using parameter identification techniques. R. C. Wingrove (NASA, Ames Research Center, Aircraft Guidance and Navigation Branch, Moffett Field, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. (A79-50426 22-01) Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 9-1 to 9-24, 22 refs.

This study compares the results from different parameter identification methods used to determine longitudinal aircraft characteristics from flight data. In general, these comparisons have found that the estimated short-period dynamics (natural frequency, damping, transfer functions) are only weakly affected by the type of identification method; however, the estimated aerodynamic coefficients may be strongly affected by the type of identification method. The estimated values for aerodynamic coefficients were found to depend upon the type of math model and type of test data used with each of the identification methods. The use of fairly complete math models and the use of long data lengths, combining both steady and nonsteady motion, are shown to provide aerodynamic coefficient values that compare favorably with the results from other testing methods such as steady-state flight and full-scale wind-tunnel experiments.

(Author)

**A79-52950 \*** Nonlinear singularly perturbed optimal control problems with singular arcs. M. D. Ardema (NASA, Ames Research Center, Moffett Field, Calif.). In: A link between science and applications of automatic control. Oxford, Pergamon Press, Ltd., 1979, p. 929-936, 18 refs.

Singular perturbation techniques are studied for dealing with singular arc problems by analyzing a relatively low-order but otherwise general system. This system encompasses many flight mechanical problems including Goddard's problem and a version of the minimum time-to-climb problem. Boundary layer solutions are constructed which are stable and reach the outer solution in a finite time. A uniformly valid composite solution is then formed from the reduced and boundary layer solutions. The value of the approximate solution is that it is relatively easy to obtain and does not involve singular arcs. To illustrate the utility of the results, the technique is used to obtain an approximate solution of a simplified version of the aircraft minimum time-to-climb problem. V.T.

**A79-53627 \* #** Flight controls/avionics research - Impact on future civil helicopter operating efficiency and mission reliability. W. J. Snyder and J. V. Christensen (NASA, Ames Research Center, Helicopter Systems Office, Moffett Field, Calif.). In: Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers, (A79-53626 24-08) Washington, D.C., American Helicopter Society, 1979, 12 p, 8 refs.

Operational efficiency and mission reliability are key capabilities which will impact the future use of helicopters in the civil segment and areas where flight control/avionics research can play a major role. The present paper reviews flight control/avionics system needs for each major area of civil helicopter use. Technology requirements to meet civil needs are discussed. The review points up the need for the development of all-weather flight control concepts and the validation of cost effective active control/fly-by-wire/fly-by-light system concepts with modular architecture which can be tailored to specific mission requirements. B.J.

## PATENTS

**N79-17847\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**CONSTANT LIFE ROTOR FOR A HEAVIER THAN AIR CRAFT Patent**

Robert H. Stroub, inventor (to NASA) Issued 30 Jan. 1979 8 p Filed 25 Jul. 1977 Supersedes N77-28111 (15 - 19, p 2426)

(NASA-Case-ARC-11045-1: US-Patent-4,137,010; US-Patent-Appl-SN-818916, US-Patent-Class-416-51; US-Patent-Class-416-88; US-Patent-Class-416-89; US-Patent-Class-416-132R; US-Patent-Class-416-138) Avail. US Patent and Trademark Office CSCL 01C

A rotor blade extended radially from a hub, characterized by an elongated spar and a plurality of axially aligned shells pivotally mounted on the spar is presented. Each has an aerodynamic center located in trailing relation with the spar and supported thereby for simultaneous axial and angular displacement as centrifugal forces are applied, a pitch controller plus a plurality of pivotal pitch limiting arms transversely related to the spar. A push-pull link interconnecting the arms is used for imparting simultaneous pivotal motion, whereby the angular relationship of the arms to the spar is varied for varying the motion of the trucks along the arms for thus limiting the pitch of the segments about the spar.

Official Gazette of the U.S. Patent and Trademark Office

**N79-23L71\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**AIRCRAFT ENGINE NOZZLE Patent Application**

Norman E. Sorensen and Edwin A. Latham, inventors (to NASA) Filed 23 Mar. 1979 14 p (NASA-Case-ARC-10977-1: US-Patent-Appl-SN-023436) Avail. NTIS HC A02/MF A01 CSCL 21E

A variable area exit nozzle arrangement for an aircraft engine having a substantially reduced length and weight is described. It comprises longitudinally movable radial vanes and fixed radial vanes. The movable radial vanes are alternately disposed with respect to the fixed radial vanes. Means for displacing the movable radial vanes along the longitudinal axis of the engine relative to the fixed radial vanes are determined. The fixed radial vanes radially extend across the main exhaust flow of the engine.

NASA

**N79-33177\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**AUTONOMOUS NAVIGATION SYSTEM Patent Application** Shmuel J. Merhav, inventor (to NASA) (National Research Council,

Haifa, Israel) Filed 24 Sep. 1979 19 p Sponsored by NASA  
(NASA-Case-ARC-11257-1; US-Patent-Appl-SN-078611) Avail:  
NTIS HC A02/MF A01 CSCL 17G

A low cost autonomous navigation system which dispenses with accelerometers used in the conventional gimballed and strapdown inertial systems is described. The navigation system provides longitudinal and lateral vehicular specific force measurements in the locally level plane irrespective of the vehicle pitch, roll, and yaw motions. The navigation system provides longitudinal and lateral velocities in locally level geography coordinates along with vehicle position, altitude and attitude information. The system minimizes the number of sensors and system complexity, thus reducing errors, while providing a rapid method of north calibration. The system is composed of an unbalanced, pendulous, two axis gimbal system with a two degree of freedom leveling gyroscope and a heading gyroscope.

A.W.H.

# ASTRONAUTICS

## FORMAL REPORTS

N79-10048# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**DIRECT NUMERICAL SOLUTION OF THE TRANSONIC PERTURBATION INTEGRAL EQUATION FOR LIFTING AND NONLIFTING AIRFOILS**

David Nixon Sep. 1978 27 p refs  
(NASA-TM-78518; A-7591) Avail. NTIS HC A03/MF A01 CSCL 01A

The linear transonic perturbation integral equation previously derived for nonlifting airfoils is formulated for lifting cases. In order to treat shock wave motions, a strained coordinate system is used in which the shock location is invariant. The tangency boundary conditions are either formulated using the thin airfoil approximation or by using the analytic continuation concept. A direct numerical solution to this equation is derived in contrast to the iterative scheme initially used, and results of both lifting and nonlifting examples indicate that the method is satisfactory.

Author

N79-10150# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**A TEMPERATURE DEPENDENT FATIGUE FAILURE CRITERION FOR GRAPHITE/EPOXY LAMINATES**

Assa Rotem and Howard G. Nelson Oct. 1978 20 p refs  
Presented at the Symp on New Dev. and Appl. in Composites. St. Louis, 15-19 Oct. 1978  
(NASA-TM-78538; A-7656) Avail. NTIS HC A02/MF A01 CSCL 11D

A fatigue failure criterion applicable to composite materials is developed and applied to predict the fatigue behavior of graphite/epoxy laminates with particular emphasis on the influence of temperature. Tensile stress-strain curves and tension-tension fatigue curves for various unidirectional, angle-ply and symmetrically balanced laminates were developed at test temperatures of 25 C, 74 C, and 114 C. For most laminates a reduction in both static strength and fatigue strength is observed with increasing temperature. This reduction appeared more severe in fatigue loading than in static tensile loading and most severe where the shear stress in the lamina is the dominate failure mode. Through an analytical formulation of shifting functions for the influences of temperature, all fatigue data are shown to be capable of being reduced to a single reference curve at some temperature. Examples are given which demonstrate the capability of the fatigue failure criterion to predict failure of complex symmetrically balanced laminates from relevant parameters obtained from the observed behavior of unidirectional and angle-ply laminates.

Author

N79-10480# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**NUMERICAL AERODYNAMIC SIMULATION FACILITY**

F. R. Bailey and A. W. Hathaway /n NASA Langley Res. Center Res. in Computerized Structural Analysis and Syn. Oct. 1978 p 15-30 refs (For primary document see N79-10448 01-39)

Avail. NTIS HC A10/MF A01 CSCL 20K

Critical to the advancement of computational aerodynamics capability is the ability to simulate flows about three-dimensional configurations that contain both compressible and viscous effects.

including turbulence and flow separation at high Reynolds numbers. Analyses were conducted of two solution techniques for solving the Reynolds averaged Navier-Stokes equations describing the mean motion of a turbulent flow with certain terms involving the transport of turbulent momentum and energy modeled by auxiliary equations. The first solution technique is an implicit approximate factorization finite-difference scheme applied to three-dimensional flows that avoids the restrictive stability conditions when small grid spacing is used. The approximate factorization reduces the solution process to a sequence of three one-dimensional problems with easily inverted matrices. The second technique is a hybrid explicit/implicit finite-difference scheme which is also factored and applied to three-dimensional flows. Both methods are applicable to problems with highly distorted grids and a variety of boundary conditions and turbulence models.

G.G.

N79-10809# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**AN EXTENSION OF A-STABILITY TO ALTERNATING DIRECTION IMPLICIT METHODS**

R. F. Warming and Richard M. Beam Oct. 1978 50 p refs  
(NASA-TM-78537; A-7614) Avail. NTIS HC A03/MF A01 CSCL 12A

An alternating direction implicit (ADI) scheme was constructed by the method of approximate factorization. An A-stable linear multistep method (LMM) was used to integrate a model two-dimensional hyperbolic-parabolic partial differential equation. Sufficient conditions for the A-stability of the LMM were determined by applying the theory of positive real functions to reduce the stability analysis of the partial differential equations to a simple algebraic test. A linear test equation for partial differential equations is defined and then used to analyze the stability of approximate factorization schemes. An ADI method for the three-dimensional heat equation is also presented. S.B.S.

N79-10810# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**DESIGN OF TRANSONIC AIRFOIL SECTIONS USING A SIMILARITY THEORY**

David Nixon Oct. 1978 21 p refs  
(NASA-TM-78521; A-7597) Avail. NTIS HC A02/MF A01 CSCL 12A

A study of the available methods for transonic airfoil and wing design indicates that the most powerful technique is the numerical optimization procedure. However, the computer time for this method is relatively large because of the amount of computation required in the searches during optimization. The optimization method requires that base and calibration solutions be computed to determine a minimum drag direction. The design space is then computationally searched in this direction. It is these searches that dominate the computation time. A recent similarity theory allows certain transonic flows to be calculated rapidly from the base and calibration solutions. In this paper the application of the similarity theory to design problems is examined with the object of at least partially eliminating the costly searches of the design optimization method. An example of an airfoil design is presented.

Author

N78-12029# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**CONFERENCE ON FIRE RESISTANT MATERIALS (FIREMEN): A COMPILATION OF PRESENTATIONS AND PAPERS**

Demetrius A. Kourtidis, ed. Oct. 1978 508 p refs Conf. held at Ames Res. Center, Moffett Field, Calif. 13-14 Apr. 1978

(NASA-TM-78523; A-7805) Avail: NTIS HC A23/MF A01 CSCL 13L

The proceedings of the NASA Fire Resistant Materials Engineering (FIREMEN) Program held at Ames Research Center on April 13, 14, 1978 are reported. The purpose of the conference was to discuss the results of NASA in the field of aircraft fire safety and fire resistant materials. The program components include the following: (1) large-scale testing; (2) fire toxicology; (3) polymeric materials; and (4) bibliography related and/or generated from the program. For individual titles, see N79-12030 through N79-12047.

N78-12040# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### **OVERVIEW OF FIREMEN PROGRAM AT AMES RESEARCH CENTER**

Demetrius A. Kourtidis *In its Conf. on Fire Resistant Mater.* Oct. 1978 p 247-282 (For primary document see N79-12029 03-03)

Avail: NTIS HC A23/MF A01 CSCL 13L

The Ames Firemen Program is described. The key elements of the program include: (1) the development and evaluation of aircraft interior composite panels; (2) the thermochemical and flammability characterization of thermoset and thermoplastic resins; and (3) the evolution of fire resist aircraft seat components. The first two elements are presented.

S.E.S.

N78-12222# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### **STRAIN-RATE/TEMPERATURE BEHAVIOR OF HIGH DENSITY POLYETHYLENE IN COMPRESSION**

Linda L. Clements and Oleg D. Sherby (Stanford Univ., Calif.) Nov. 1978 10 p refs

(NASA-TM-78544; A-7679) Avail: NTIS HC A02/MF A01 CSCL 07C

The compressive strain rate/temperature behavior of highly linear, high density polyethylene was analyzed in terms of the predictive relations developed for metals and other crystalline materials. For strains of 5 percent and above, the relationship between applied strain rate, dotted epsilon, and resulting flow stress, sigma, was found to be: dotted epsilon exp times (Q sub f / RT) - k(sigma/sigma sub c) to the nth power, the left-hand side is the activation-energy-compensated strain rate, where Q sub f is activation energy for flow, R is gas constant, and T is temperature, k is a constant, n is temperature-independent stress exponent, and sigma/sigma sub c is structure-compensated stress. A master curve resulted from a logarithmic plot of activation-energy-compensated strain rate versus structure-compensated stress.

Author

N79-12363# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### **ON THE MEASUREMENT OF TURBULENT FLUCTUATIONS IN HIGH-SPEED FLOWS USING HOT WIRES AND HOT FILMS**

Mukund Acharya Nov. 1978 20 p refs  
(NASA-TM-78535; A-7641) Avail: NTIS HC A02/MF A01 CSCL 20D

A hot wire has a limited life in high speed wind-tunnel flows because it is typically subjected to large dynamic loads. As a consequence hot films and modified hot wires are frequently used for turbulence measurements in such flows. However, the fluctuation sensitivities of such probes are reduced because of various factors, leading to erroneous results. This paper describes

the results of tests on some sensors in both subsonic and supersonic boundary-layer flows. A simple technique to determine dynamic calibration correction factors for the sensitivities is also presented.

Author

N78-13473# San Jose State Coll. Foundation, Calif. Dept. of Geology.

#### **A STUDY TO EXAMINE THE FEASIBILITY OF USING SURFACE PENETRATORS FOR MINERAL EXPLORATION**

Final Technical Report, May 1977 - Dec. 1978

Alice S. Davis and David W. Anderson Dec. 1978 49 p refs (Grant NaG-2238)

Avail: NTIS HC A03/MF A01 CSCL 08G

The feasibility of using penetrators in earth applications is examined. Penetrator applications in exploration for mineral resources only is summarized. Instrumentation for future penetrators is described. Portions of this report are incorporated into a more extensive report examining other penetrator applications in exploration for fossil fuels, geothermal resources, and in environmental and engineering problems, which is to be published as a NASA technical publication.

G.Y.

N79-14700# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### **A SIMULATOR STUDY OF THE INTERACTION OF PILOT WORKLOAD WITH ERRORS, VIGILANCE, AND DECISIONS**

H. P. Ruffell Smith Jan. 1979 58 p refs

(NASA-TM-78472; A-7354) Avail: NTIS HC A04/MF A01 CSCL 05H

A full mission simulation of a civil air transport scenario that had two levels of workload was used to observe the actions of the crews and the basic aircraft parameters and to record heart rates. The results showed that the number of errors was very variable among crews but the mean increased in the higher workload case. The increase in errors was not related to rise in heart rate but was associated with vigilance times as well as the days since the last flight. The recorded data also made it possible to investigate decision time and decision order. These also varied among crews and seemed related to the ability of captains to manage the resources available to them on the flight deck.

G.G.

S

N79-15088# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### **THE ROLE OF TIME-HISTORY EFFECTS IN THE FORMULATION OF THE AERODYNAMICS OF AIRCRAFT DYNAMICS**

Murray Tobak and Lewis B. Schiff *In AGARD Dyn. Stability Parameters* Nov. 1978 10 p refs (For primary document see N79-15061 06-08)

Avail: NTIS HC A99/MF A01

The scope of any aerodynamic formulation proposing to embrace a range of possible maneuvers is shown to be determined principally by the extent to which the aerodynamic indicial response is allowed to depend on the past motion. Starting from the linearized formulation, in which the indicial response is independent of the past motion two successively more comprehensive statements about the dependence on the past motion are assigned to the indicial response (1) dependence only on the recent past and (2) dependence additionally on a characteristic feature of the distant past. The first enables the rational introduction of nonlinear effects and accommodates a description of the rate-dependent aerodynamic phenomena characteristic of airfoils in low-speed dynamic stall, the second permits a description of the double-valued aerodynamic behavior characteristic of certain kinds of aircraft stall. An aerodynamic formulation based on the second statement, automatically embracing the first, may be sufficiently comprehensive to include a large part of the aircraft's possible maneuvers. The results suggest a favorable conclusion regarding the role of dynamic stability experiments in flight dynamics studies.

Author

N79-15187# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**FLASH-FIRE PROPENSITY AND HEAT-RELEASE RATE STUDIES OF IMPROVED FIRE RESISTANT MATERIALS**  
Larry L. Fewell Dec. 1978 46 p  
(NASA-TM-78550; A-7548) Avail: NTIS HC A03/MF A01 CSCL 11E

Twenty-six improved fire resistant materials were tested for flash-fire propensity and heat release rate properties. The tests were conducted to obtain a descriptive index based on the production of ignitable gases during the thermal degradation process and on the response of the materials under a specific heat load.

Author

N79-15989# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.  
**VISUALLY INDUCED MOTION IN FLIGHT SIMULATION**  
Lawrence R. Young /n AGARD Piloted Aircraft Environ. Simulation Tech. Oct. 1978 8 p refs (For primary document see N79-15973 07-09)  
(Grant NsG-2236; Contract F33615-76-C-0039)  
Avail: NTIS HC A14/MF A01 CSCL 01E

Visually induced yaw (circularvection) resulting from a moving wide field presentation, and its interaction with vestibular yaw cues generated by base motion is discussed. A model is presented for the interaction between visual and motion cues in yaw which rationalizes the high frequency utilization of vestibular cues and the low frequency use of visual cues to support sustained angular velocity. The implications for fixed and moving base flight simulator design are discussed. Similar considerations apply to visually induced linear velocity (linearvection) and interesting symmetries in the fore-aft direction are noted. Visually induced pitch and roll are discussed and modelled in terms of conflict between the visually induced motion and the information regarding attitude based upon graviceptor signals.

S.E.S

N79-16493# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**A SIMPLIFIED METHOD FOR CALCULATING THE ATMOSPHERIC HEATING RATE BY ABSORPTION OF SOLAR RADIATION IN THE STRATOSPHERE AND MESOSPHERE**  
Tatsuo Shimazaki and Leland C. Helmreich (Informatics, Inc., Palo Alto, Calif.) Jan. 1979 34 p refs  
(NASA-TP-1398; A-7557) Avail: NTIS HC A04/MF A01 CSCL 04B

Calculations of the atmospheric heating rate by absorption of solar radiation by O<sub>3</sub>, H<sub>2</sub>O, and CO<sub>2</sub> are reported. The method needs only seven parameters for each molecule and is particularly useful for heating calculations in three-dimensional global circulation models below 80 km. Applying the formula to the observed distributions of O<sub>3</sub>, H<sub>2</sub>O, and CO<sub>2</sub> produces reasonable latitudinal and seasonal variations in the heating rate. The calculated heating rate, however, is sensitive to the global distributions of the absorbing gases, and uncertainties in the O<sub>3</sub> distribution above approximately 50 km and the H<sub>2</sub>O distribution below approximately 20 km may seriously affect the global distributions of the heating rate in these regions.

G.G

N79-16709# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**A CRITICAL REVIEW OF THE LIFE SCIENCES PROJECT MANAGEMENT AT AMES RESEARCH CENTER FOR THE SPACELAB MISSION DEVELOPMENT TEST 3**  
Robert Helmreich (Texas Univ., Austin), John Wilhelm (Texas Univ., Austin), Trieve A. Tanner (California State Univ., Hayward), Joan E. Sieber (Texas Univ., Austin), and Susan Burgenbach Jan. 1979 66 p refs  
(Grant NsG-2065; NCA2-OR290-705)  
(NASA-TP-1364; A-7536) Avail: NTIS HC A04/MF A01 CSCL 05A

A management study was initiated by ARC (Ames Research Center) to specify Spacelab Mission Development Test 3 activities

and problems. This report documents the problems encountered and provides conclusions and recommendations to project management for current and future ARC life sciences projects. An executive summary of the conclusions and recommendations is provided. The report also addresses broader issues relevant to the conduct of future scientific missions under the constraints imposed by the space environment.

G.Y.

N79-16760# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif. Space Science Div.

#### **ORIGIN AND EVOLUTION OF THE SATURN SYSTEM: OBSERVATIONAL CONSEQUENCES**

James B. Pollack /n JPL The Saturn System Dec. 1978 p 9-30 refs (For primary document see N79-16758 07-91)  
Avail: NTIS HC A18/MF A01 CSCL 03B

A number of important cosmogonic questions concerning the Saturn system can be addressed with a Saturn orbiter-dual-probe spacecraft mission. These questions include: The origin of the Saturn system; the source of Saturn's excess luminosity; the mechanism by which the irregular satellites were captured; the influence of Saturn's early luminosity on the composition of its regular satellites; and the origin of the rings. The first two topics can be studied by measurements made from an entry probe into Saturn's atmosphere, while the remaining issues can be investigated by measurements conducted from an orbiter. Background information is provided on these five questions describing the critical experiments needed to help resolve them.

G.G.

N79-16768# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif. Space Science Div.

#### **PHYSICAL PROPERTIES OF AEROSOLS IN TITAN'S ATMOSPHERE AS DEDUCED FROM VISIBLE OBSERVATIONS**

Kathy Rages and James B. Pollack /n JPL The Saturn System Dec. 1978 p 149-160 refs (For primary document see N79-16758 07-91)  
Avail: NTIS HC A18/MF A01 CSCL 03B

Analysis of the absolute value of Titan's albedo and its variation with increasing phase angle has yielded constraints on the optical properties and average particle size of the aerosols responsible for the scattering of visible light. The real index of refraction of the scattering material lies within the range 1.5 approximately less than nr approximately less than 2.0 and the average particle size is somewhere between 0.2 micrometer and 0.4 micrometer. The amount of limb darkening produced by these models leads to an occultation radius of approximately 2700 km.

Author

N79-16780# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**OUTER PLANET PROBE MISSIONS, DESIGNS AND SCIENCE**

Lawrence Colin /n JPL The Saturn System Dec. 1978 p 361-378 (For primary document see N79-16758 07-91)  
Avail: NTIS HC A18/MF A01 CSCL 03B

The similarities and differences of atmosphere entry probe mission designs and sciences appropriate to certain solar system objects, are reviewed. Candidate payloads for Saturn and Titan probes are suggested. Significant supporting research and technology efforts are required to develop mission-peculiar technology for probe exploration of the Saturnian system.

G.G.

N79-16800# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**SUPERCRITICAL FLOW ABOUT A THICK CIRCULAR-ARC AIRFOIL**

John B. McDevitt Jan. 1979 84 p refs

(NASA-TM-78549; A-7693) Avail: NTIS HC A05/MF A01 CSCL 01A

The supercritical flow about a biconvex circular-arc airfoil is being thoroughly documented at Ames Research Center in order to provide experimental test cases suitable for guiding and evaluating current and future computer codes. The effects of angle of attack, effects of leading and trailing-edge splitter plates, additional unsteady pressure fluctuation (buffeting) measurements and glow-field shadowgraphs, and application of an oil-film technique to display separated-wake streamlines were studied. Computed and measured pressure distributions for steady and unsteady flows, using a recent computer code representative of current methodology, are compared. It was found that the numerical solutions are often fundamentally incorrect in that only strong (shock-polar terminology) shocks are captured, whereas experimentally, both strong and weak shock waves appear.

S.E.S.

N79-16918\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**EFFECT OF MOISTURE ON THE FATIGUE BEHAVIOR OF GRAPHITE/EPOXY COMPOSITE LAMINATES**

S. V. Raman (Virginia Polytechnic Inst. and State Univ., Blacksburg) and H. G. Nelson Jan. 1979 49 p refs (NASA-TM-78548; A-7689) Avail: NTIS HC A03/MF A01 CSCL 11D

The form of the moisture distribution in the specimen (gradient and flat profile) was considered to establish the influence of accelerated moisture conditioning on fatigue behavior. For the gradient specimens having an average moisture content of 1.4 percent, fatigue life was reduced by a factor of 8 at all stress levels investigated. Corresponding reduction in fatigue life for the flat moisture profile specimens at the same average moisture content was comparatively smaller, being about a factor of 5 from the value in dry specimens. X-ray radiographic analysis of damage accumulation in compression-compression fatigue revealed interlaminar cracking to be the dominant mode of failure responsible for the observed enhanced cyclic degradation of moisture-conditioned specimens. This finding was corroborated by the observed systematic reduction in interlaminar shear strength as a function of moisture content, which, in turn, increased the propensity for delamination under cyclic compressive loads. Residual strength measurements on cycled specimens indicated significant strength reductions at long lives, particularly in moisture conditioned specimens.

J.A.M.

N79-18287\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**TRANSIENT SHUTDOWN ANALYSIS OF LOW-TEMPERATURE THERMAL DIODES**

Richard J. Williams Mar 1979 21 p refs (NASA-TP-1369; A-7642) Avail: NTIS HC A02/MF A01 CSCL 20D

The various thermal diodes available for use in cryogenic systems are described. Two diode types, liquid-trap and liquid-blockage diodes, were considered to be the most attractive, and thermal models were constructed to predict their behavior in the reverse mode. The diodes, which are of similar size and throughput, were also examined experimentally in a parallel test setup under nominally identical conditions. Their characteristics were ascertained in terms of forward-mode and reverse-mode conductances, shutdown times and energies, and recovery to forward-mode operation with ethane as the working fluid in the temperature range 170 K to 220 K. Results show that the liquid-blockage diode is the quicker of the two diodes to shut down from the forward mode (8 min as opposed to 10 min). However, the liquid-blockage diode has a larger reverse-mode conductance which results in a greater overall evaporator temperature rise. The importance of the relative size and heat inputs to the condenser/reservoir configuration of the liquid-blockage diode and the evaporator trap configuration for the liquid-trap diode are demonstrated. Also included are data which show the susceptibility of the diodes to recovery to forward-mode operation. Guidelines for the choice of a particular diode for an actual application are given.

J.M.S.

N79-18297\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**TIME-DEPENDENT LOCAL DENSITY MEASUREMENTS IN UNSTEADY FLOWS**

R. L. McKenzie, D. J. Monson, and R. J. Exberger Feb. 1979 21 p refs (NASA-TM-78555; A-7720) Avail: NTIS HC A02/MF A01 CSCL 14B

A laser-induced fluorescence technique for measuring the relative time-dependent density fluctuations in unsteady or turbulent flows is demonstrated. Using a 1.5-W continuous-wave Kr(+) laser, measurements have been obtained in 0.1-mm-diameter by 1-mm-long sampling volumes in a Mach 3 flow of N<sub>2</sub> seeded with biacetyl vapor. A signal amplitude resolution of 2% was achieved for a detection frequency bandwidth of 10 kHz. The measurement uncertainty was found to be dominated by noise behaving as photon statistical noise. The practical limits of signal-to-noise ratios have been characterized for a wide range of detection frequency bandwidths that encompasses those of interest in supersonic turbulence measurements.

Author

N79-18946\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**SOME RECENT PROGRESS IN TRANSONIC FLOW COMPUTATION**

William F. Ballhaus /in Von Karman Inst. for Fluid Dyn. Computational Fluid Dyn., Vol. 1 1976 122 p refs (For primary document see N79-18943 10-02)

Avail: NTIS HC A19/MF A01 CSCL01A

Although the development of a finite difference relaxation procedure to solve the steady form of equations of motion gave birth to the study of computational transonic aerodynamics and considerable progress has been made using the small disturbance theory, no general analytical solution method yet exists for transonic flows that include three dimensional unsteady, and viscous effects. Two techniques are described which are useful in computational transonic aerodynamics applications. The finite volume method simplifies the application of boundary conditions without introducing the constriction associated with small disturbance theory. Governing equations are solved in a Cartesian coordinate system using a body-oriented and shock-oriented mesh network. Only the volume and surface normal directions of the volume elements must be known. The other method, configuration design by numerical optimization, can be used by aircraft designers to develop configurations that satisfy specific geometric performance constraints. Two examples of airfoil design by numerical optimization are presented.

A.R.H.

S

N79-18952\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**STATUS AND PROSPECTS OF COMPUTATIONAL FLUID DYNAMICS**

Dean R. Chapman /in Von Karman Inst. for Fluid Dyn. Computational Fluid Dyn., Vol. 2 1976 36 p (For primary document see N79-18948 10-02)

Avail: NTIS HC A19/MF A01 CSCL01A

The use and limitations on using computational aerodynamics in approximating inviscid linear, inviscid nonlinear, viscous time averaged, and viscous time dependent flow past airfoils, wings, and aircraft is reviewed. The current status of two- and three-dimensional time averaged Navier-Stokes equation is discussed and possible applications for the 1980 and 1985 to 1990 period is projected for three-dimensional applications.

A.R.H.

N79-19018\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**OUTER PLANETS PROBE TESTING**

c15

J. A. Smittkamp (McDonnell Douglas Astronautics Co., St. Louis, Mo.), M. G. Grote (McDonnell Douglas Astronautics Co., St. Louis, Mo.), and T. M. Edwards /in NASA Goddard Space Flight Center Ninth Conf. on Space Simulation 1977 p 65-83 (For primary document see N79-19013 10-12)

(Contract NAS2-9027)

Avail: NTIS HC A20/MF A01 CSCL 22B

An atmospheric entry Probe is being developed by NASA Ames Research Center (ARC) to conduct *in situ* scientific investigations of the outer planets' atmospheres. A full scale engineering model of an MDAC-E Probe configuration, was fabricated by NASA ARC. Proof-of-concept test validation of the structural and thermal design is being obtained at NASA ARC. The model was successfully tested for shock and dynamic loading and is currently in thermal vacuum testing. G.Y.

N79-20030\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PROSPECTS FOR COMPUTING AIRFOIL AERODYNAMICS WITH REYNOLDS AVERAGED NAVIER-STOKES CODES**  
George S. Deiwert and H. E. Bailey *In NASA, Langley Res. Center Advanced Technol. Airfoil Res., Vol. 1, Pt. 1* 1979 p 119-131 refs (For primary document see N79-20030 11-02)  
Avail: NTIS HC A20/MF A01 CSCL 01A

The Reynolds averaged Navier-Stokes equations are solved numerically for a variety of transonic airfoil configurations where viscous phenomena are important. Illustrative examples include flows past sensitive geometries, Reynolds number effects, and buffet phenomena. J.M.S.

N79-20061\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**COMPUTATION OF TURBULENT NEAR WAKE FOR ASYMMETRIC AIRFOILS**  
George S. Deiwert Mar. 1979 16 p refs Presented at the DEA meeting on Viscous and Interacting Flow Field Effects, Meersburg/Bodensee, West Germany, 24-26 Apr. 1979 (NASA-TM-78581; A-7803) Avail: NTIS HC A02/MF A01 CSCL 01A

A numerical procedure for studying the turbulent near wake of two dimensional airfoil sections is presented. The Reynolds Navier-Stokes equations were written for flow about bodies of arbitrary geometry and solved on an arbitrary nonuniform curvilinear computational mesh. Eddy viscosity and Reynolds stress turbulence transport models are considered. Specific examples are shown for airfoil section by using an algebraic viscosity model with streamwise relaxation and the interactive Reynolds stress model. S.E.S.

N79-20588\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**ADVANCES IN LOCAL AREA, MESOSCALE MODELING**  
Paul R. Swan and Young Lee *In NASA, Goddard Space Flight Center 3d NASA Weather and Climate Program Sci. Rev.* 1977 p 55-59 refs (For primary document see N79-20575 11-47)  
Avail: NTIS HC A14/MF A01 CSCL 04B

A two-layer, mesoscale boundary layer model is being developed and validated against San Francisco Bay Area observational data. Author

N79-20603\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**STRATOSPHERIC AEROSOLS AND CLIMATIC CHANGE**  
James B. Pollack and Owen B. Toon *In NASA, Goddard Space Flight Center 3d NASA Weather and Climate Program Sci. Rev.* 1977 p 159-163 refs (For primary document see N79-20575 11-47)  
Avail: NTIS HC A14/MF A01 CSCL 04B

The effect of stratospheric aerosols on climate is considered using an aerosol model and a radiative convective 1-D climate model. Author

N79-20675\*/# National Aeronautics and Space

Administration. Ames Research Center, Moffett Field, Calif.

**APPLICATION OF A COUPLED AEROSOL RADIATION: RADIATIVE TRANSFER MODEL TO CLIMATIC STUDIES OF AEROSOLS**

O. B. Toon and J. B. Pollack *In NASA, Goddard Space Flight Center 4th NASA Weather and Climate Program Sci. Rev.* 1979 p 253-257 refs (For primary document see N79-20633 11-47)  
Avail: NTIS HC A17/MF A01 CSCL 04B

A sophisticated one dimensional physical-chemical model of the formation and evolution of stratospheric aerosols was used to predict the size and number concentration of the stratospheric aerosols as functions of time and altitude following: a large volcanic eruption; increased addition of carbonyl sulfide (OCS) or sulfur dioxide (SO<sub>2</sub>) to the troposphere; increased supersonic aircraft (SST) flights in the stratosphere; and, large numbers of space shuttle (SS) flights through the stratosphere. A radiative-convective one dimensional climate sensitivity study, using the results of the aerosol formation model, was performed to assess the ground level climatic significance of these perturbations to the stratospheric aerosol layer. Volcanic eruptions and large OCS or SO<sub>2</sub> increases could cause significant climatic changes. Currently projected SS launches and moderate fleets of SST's are unlikely to upset the stratospheric aerosol layer enough to significantly impact climate. J.M.S.

N79-20785\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**ALTERNATING DIRECTION IMPLICIT METHODS FOR PARABOLIC EQUATIONS WITH A MIXED DERIVATIVE**  
Richard M. Beam and R. F. Warming Mar. 1979 58 p refs (NASA-TM-78569; A-7766) Avail: NTIS HC A04/MF A01 CSCL 12A

Alternating direction implicit (ADI) schemes for two-dimensional parabolic equations with a mixed derivative are constructed by using the class of all A sub 0-stable linear two-step methods in conjunction with the method of approximation factorization. The mixed derivative is treated with an explicit two-step method which is compatible with an implicit A sub 0-stable method. The parameter space for which the resulting ADI schemes are second order accurate and unconditionally stable is determined. Some numerical examples are given. Author

N79-20841\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**DETERMINATION OF THE TELLURIC WATER VAPOR ABSORPTION CORRECTION FOR ASTRONOMICAL DATA OBTAINED FROM THE KUIPER AIRBORNE OBSERVATORY**

E. F. Erickson, J. P. Simpson, P. M. Kuhn (NOAA, Boulder, Colo.), and L. P. Stearns (NOAA, Boulder, Colo.) Apr. 1979 13 p refs (NASA-TM-78582; A-7805) Avail: NTIS HC A02/MF A01 CSCL 03A

The amount of telluric water vapor along the line of sight of the Kuiper Airborne Observatory telescope as obtained concomitantly on 23 flights is compared with the NASA-Ames Michelson interferometer and with the NOAA-Boulder radiometer. A strong correlation between the two determinations exists, and a method for computing the atmospheric transmission for a given radiometer reading is established. G.Y.

N79-21307\*/# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**EXPERIMENTS ON THE LARGE-SCALE STRUCTURE OF TURBULENCE IN THE NEAR-JET REGION**  
M. A. Badri-Narayanan and Donald M. Kuehn Apr. 1979 30 p refs (NASA-TM-78567; A-7756) Avail: NTIS HC A03/MF A01 CSCL 20D

The near region of an axisymmetric, turbulent jet was

investigated. Turbulence quantities, as well as mean velocities, were measured between 3 and 23 diam away from the nozzle. The mean velocity profiles were similar over most of this distance, whereas the turbulence quantities were far from equilibrium conditions. Across the jet, the rate of large-scale turbulence varied considerably; however, a Strouhal number based on local velocity, the diameter of the jet, and the frequency of the large-scale turbulent oscillation remained relatively constant. The formation of the initial instability waves and the pairing of the vortices were examined. Turbulent fluctuations were observed only downstream of the pairing process.

Author

**N79-21365# Hughes Aircraft Co., Culver City, Calif.  
DEPLOYMENT MECHANISMS ON PIONEER VENUS PROBES**

W. L. Townsend, R. H. Miyakawa, and F. R. Meadows /n NASA Ames Res. Center The 12th Aerospace Mech. Symp. Apr. 1979 p 143-155 (For primary document see N79-21352 12-37) (Contract NAS2-8300)

Avail: NTIS HC A11/MF A01 CSCL 20K

Deployment mechanisms were developed to position scientific instruments during probe descent into the Venus atmosphere. Each mechanism includes a provision for pyrotechnic release of the enclosure door, negotiator springs for positive deployment torque, and an active damper using a shunted dc motor. The deployment time requirement is under 2 seconds, and the deployment shock must be less than 100 g's. The mechanism is completely dry lubricated and constructed mainly of titanium for high strength and high temperature stability. The mechanism was qualified for descent decelerations up to 565 g's and for instrument alignment up to 940 F. The mechanism requirements, the hardware design details, the analytical simulations, and the qualification testing are described.

J.M.S.

**N79-21377# Hughes Aircraft Co., El Segundo, Calif.  
MAGNETOMETER DEPLOYMENT MECHANISM FOR PIONEER VENUS**

William L. Townsend /n NASA Goddard Space Flight Center The 11th Aerospace Mech. Symp. 28 Apr. 1977 p 23-33 (For primary document see N79-21374 12-37) (Contract NAS2-8300)

Avail: NTIS HC A11/MF A01 CSCL 20K

A three segment, 15-foot boom mechanism was developed to deploy magnetometers from the Pioneer Venus orbiter spinning shelf. The stowage mechanism is designed to contain the magnetometers during launch and to deploy these instruments by centrifugal force upon pyrotechnic release. Unique graphite-epoxy boom segments are used for a lightweight design with sufficient strength to withstand a 7.5 g orbit insertion force while extended. The detailed design is described, along with the test methods developed for qualification in a one-g field. Author

**N79-21720# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.**

**THE NASA-AMES RESEARCH CENTER STRATOSPHERIC AEROSOL MODEL. 2. SENSITIVITY STUDIES AND COMPARISON WITH OBSERVATORIES**

O. B. Toon, R. P. Turco (R and D Associates, Marina del Rey, Calif.), P. Hamill, C. S. Kiang (National Center for Atmospheric Research), and R. C. Whitten Apr. 1979 70 p refs (NASA-TP-1363, A-7551) Avail: NTIS HC A04/MF A01 CSCL 04A

Sensitivity tests were performed on a one-dimensional, physical-chemical model of the unperturbed stratospheric aerosols, and model calculations were compared with observations. The tests and comparisons suggest that coagulation controls the particle number mixing ratio, although the number of condensation nuclei at the tropopause and the diffusion coefficient at high altitudes are also important. The sulfur gas source strength and the aerosol residence time are much more important than the supply of condensation nuclei in establishing mass and large particle concentrations. The particle size is also controlled

mainly by gas supply and residence time. In situ observations of the aerosols and laboratory measurements of aerosols, parameters that can provide further information about the physics and chemistry of the stratosphere and the aerosols found there are provided.

G.Y.

**N79-21721# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.**

**THE NASA-AMES RESEARCH CENTER STRATOSPHERIC AEROSOL MODEL. 1. PHYSICAL PROCESSES AND COMPUTATIONAL ANALOGS**

R. P. Turco (R and D Associates, Marina del Rey, Calif.), P. Hamill, O. B. Toon, R. C. Whitten, and C. S. Kiang (National Center for Atmospheric Research) Apr. 1979 100 p refs (NASA-TP-1362, A-7532) Avail: NTIS HC A05/MF A01 CSCL 04A

A time-dependent one-dimensional model of the stratospheric sulfate aerosol layer is presented. In constructing the model, a wide range of basic physical and chemical processes are incorporated in order to avoid predetermining or biasing the model predictions. The simulation, which extends from the surface to an altitude of 58 km, includes the troposphere as a source of gases and condensation nuclei and as a sink for aerosol droplets. The size distribution of aerosol particles is resolved into 25 categories with particle radii increasing geometrically from 0.01 to 2.56 microns such that particle volume doubles between categories.

Author

**N79-21882# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.**

**ABSOLUTE MEASUREMENTS OF THE ELECTRONIC TRANSITION MOMENTS OF SEVEN BAND SYSTEMS OF THE C2 MOLECULE Ph.D. Thesis - York Univ., Toronto**

David M. Cooper Apr. 1979 172 p refs (NASA-TM-78574, A-7791) Avail: NTIS HC A08/MF A01 CSCL 20H

Electronic transition moments of seven C2 singlet and triplet band systems in the 0.2-1.2 micron spectral region were measured. The measurements were made in emission behind incident shock waves in C<sub>2</sub>H<sub>2</sub>-argon mixtures. Narrow bandpass radiometers were used to obtain absolute measurements of shock-excited C2 radiation from which absolute electronic transition moments are derived by a synthetic spectrum analysis. New results are reported for the Ballik-Ramsay Phillips, Swin Deslandres-d'Azambuja, Fox-Herzberg, Mulliken, and Freymark systems.

Author

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**N79-21882# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.**

**VISCOOSITY AND THERMAL CONDUCTIVITY OF MODEL JUPITER ATMOSPHERES**

C. Frederick Hansen Apr. 1979 26 p refs (NASA-TM-78556, A-7775) Avail: NTIS HC A03/MF A01

The viscosity and thermal conductivity coefficient are estimated for three models of the atmosphere of Jupiter: a heavy model consisting of 22% helium and 78% hydrogen, a nominal model consisting of 11% helium and 89% hydrogen, and a light model consisting of pure hydrogen. The effect of trace elements is neglected. Linearized approximations are used for the transport coefficients of the mixtures; these are found to be in almost constant ratio to the values for pure hydrogen, independent of temperature. Short Basic language programs for computing the coefficients are listed.

Author

**N79-21977# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.**

**FIELD MEASUREMENTS OF PENETRATOR SEISMIC COUPLING IN SEDIMENTS AND VOLCANIC ROCKS**

Yosio Nakamura (Texas Univ., Galveston), Gary V. Latham (Texas Univ., Galveston), Cliff Frohlich (Texas Univ., Galveston), Maxwell B. Blanchard (Johnson Space Center, Houston, Tex.), and James

P. Murphy Apr. 1979 60 p  
(NASA-TM-78572: A-7770) Avail: NTIS HC A04/MF A01  
CSCL 03B

Field experiments were conducted to determine how well a seismometer installed using a penetrator would be coupled to the ground. A dry-lake bed and a lava bed were chosen as test sites to represent geological environments of two widely different material properties. At each site, two half-scale penetrators were fired into the ground, a three-component geophone assembly was mounted to the aft end of each penetrator, and dummy penetrators were at various distances to generate seismic signals. These signals were detected by the penetrator-mounted geophone assembly and by a reference geophone assembly buried or anchored to surface rock and 1-m from the penetrator. The recorded signals were digitized, and cross-spectral analyses were performed to compare the observed signals in terms of power spectra, density ratio, coherence, and phase difference. The analyses indicate that seismometers deployed by penetrators will be as well coupled to the ground as are seismometers installed by conventional methods for the frequency range of interest in earthquake seismology.

A.R.H.

**N79-22688\*#** Ohio Dept. of Economic and Community Development, Columbus.

**DEVELOPMENT OF A MULTI-DISCIPLINARY ERTS USER PROGRAM IN THE STATE OF OHIO. VOLUME 1: EXECUTIVE SUMMARY** Final Report

Paul E. Baldridge, Charles Weber, Gary Schaal (Ohio Dept. of Natural Resources), Carl Wilhelm (EPA), G. E. Wurelic (Battelle Columbus Lab.), J. G. Stephan (Battelle Columbus Labs.), T. F. Ebbert (Battelle Columbus Labs.), H. E. Smail (Battelle Columbus Labs.), J. McKeon (Ben Dix Aerospace Systems Div.), and N. Schmidt, Principal Investigators (Bendix Aerospace Systems Div.) 5 Feb. 1977 430 p refs Original contains color imagery. Original photography may be purchased from the EROS Data Center, Sioux Falls, S. D. 57198 ERTS

(Contract NAS2-2399)

(E79-10187: NASA-CR-158447) Avail: NTIS HC A19/MF A01 CSCL 05B

The author has identified the following significant results. A current uniform land inventory was derived, in part, from LANDSAT data. The State has the ability to convert processed land information from LANDSAT to Ohio Capability Analysis Program (OCAP). The OCAP is a computer information and mapping system comprised of various programs used to digitally store, analyze, and display land capability information. More accurate processing of LANDSAT data could lead to reasonably accurate, useful land allocations models. It was feasible to use LANDSAT data to investigate minerals, pollution, land use, and resource inventory. Deslandres-d'Azambuja, Fox-Herzberg, Mulliken, and Freymark systems.

Author

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**N79-22615\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**INTRODUCTORY ASSESSMENT OF ORBITING REFLECTIONS FOR TERRESTRIAL POWER GENERATION**

Kenneth W. Billman, William P. Gilbreath, and Stuart W. Bowen Apr. 1977 58 p refs

(NASA-TM-73230: A-6996) Avail: NTIS HC A04/MF A01 CSCL 10A

The use of orbiting mirrors for providing energy to ground conversion stations to produce electrical power is shown to be a viable, cost effective and environmentally sound alternative to satellite solar power stations and conventional power sources. This is accomplished with the use of very light weight metal coated polymeric films as mirrors which, after deployment at 800 km, are placed in operational orbit and controlled by solar radiation pressure. Relations are developed showing the influence of a number of parameters (mirror altitude, orbit inclination, period, mirror size and number, and atmospheric effects) on the reflected insolation that may be received by a ground spot as a function of location. Some attractive alternative uses of the reflection are briefly discussed as a beneficial adjuncts to the system.

Author

**N79-22988\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**INHOMOGENEOUS MODELS OF THE VENUS CLOUDS CONTAINING SULFUR**

Sheldon M. Smith, James B. Pollack, Lawrence P. Giver, Jeffrey N. Cuzzi, and Morris Podolak (Tel-Aviv Univ.) Apr. 1979 57 p refs

(NASA-TM-78558: A-7701) Avail: NTIS HC A04/MF A01 CSCL 03B

Based on the suggestion that elemental sulfur is responsible for the yellow color of Venus, calculations are compared at 3.4 microns of the reflectivity phase function of two sulfur containing inhomogeneous cloud models with that of a homogeneous model. Assuming reflectivity observations with 25% or less total error, comparison of the model calculations leads to a minimum detectable mass of sulfur equal to 7% of the mass of sulfuric acid for the inhomogeneous drop model. For the inhomogeneous cloud model the comparison leads to a minimum detectable mass of sulfur between 17% and 38% of the mass of the acid drops, depending upon the actual size of the large particles. It is concluded that moderately accurate 3.4 microns reflectivity observations are capable of detecting quite small amounts of elemental sulfur at the top of the Venus clouds.

G.Y.

**N79-23280\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**A NEW BASIS FOR THE DETERMINATION OF FRACTURE TOUGHNESS**

S. Banerjee (Indian Inst. of Technol.) May 1979 49 p refs

(NASA-TM-78592: A-7837) Avail: NTIS HC A03/MF A01 CSCL 20K

A study is presented which shows that the growth of the plastic zone and the constraint in a compact tension specimen depends significantly on specimen width. The analysis permits the estimation of the contribution of the growth of plastic zone to the deviation from linearity. The contribution of the crack growth to the deviation from linearity is evaluated from the analysis of a typical R-curve data. A combination of these two analyses enables one to define a very simple procedure for the determination of fracture toughness. The fracture toughness is defined as the stress intensity value at which the crack extension starts. The good agreement between analytical results and experimental K<sub>Q</sub> and K<sub>IC</sub> values determined over a wide range of thicknesses, widths, and materials justifies the proposed procedures. The K<sub>IC</sub> determined according to this procedure is independent of specimen width and such a procedure enhances the range of applicability of the K concept to a wider combination of configurations and materials.

Author

**N79-23628\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**WILDLIFE MONITORING PROGRAM PLAN**

Paul Sebesta and Roger Arno Apr. 1979 233 p refs

(NASA-TM-78578: A-7781) Avail: NTIS HC A11/MF A01 CSCL 06C

A plan for integrating the various requirements for wildlife monitoring with modern aerospace technology is presented. This plan is responsive to user needs, recognizes legal requirements, and is based on an evolutionary growth from domestic animals and larger animals to smaller, more scarce and remote species. The basis for animal study selection was made from the 1973 Santa Cruz Summer Study on Wildlife Monitoring. As techniques are developed the monitoring and management tasks will be interfaced with and eventually operated by the user agencies. Field efforts, aircraft and satellites, will be supplemented by laboratory investigations. Sixty percent of the effort will be in hardware research and development (satellite technology, microminiaturization) and the rest for gathering and interpreting data.

Author

N79-23908# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AN IMPLICIT ALGORITHM FOR THE CONSERVATIVE, TRANSONIC FULL-POTENTIAL EQUATION WITH EFFECTIVE ROTATED DIFFERENCING**

Terry L. Holst and John Albert (Santa Clara Univ., Calif.) Apr. 1979 37 p refs  
(Contract NCA2-OR-685-803)  
(NASA-TM-78570) Avail: NTIS HC A03/MF A01 CSCL 01A

A new differencing scheme for the conservative full potential equation which effectively simulates rotated differencing is presented. The scheme was implemented by an appropriate upwind bias of the density coefficient along coordinate directions. A fast, fully implicit, approximate factorization iteration scheme was then used to solve the resulting difference equations. Solutions for a number of traditionally difficult transonic airfoil test cases are presented.  
J.A.M.

N79-25055# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**INFRARED RADIATION FROM THE SPACE SHUTTLE CONTAMINANT ENVIRONMENT** c18

J. P. Simpson and F. C. Witteborn /n AFML Proc. of the USAF/NASA Intern. Spacecraft Contamination Conf. 1978 p 176-207 refs (For primary document see N79-25048 16-12)  
(Contract NAS2-9636)

Avail: NTIS HC A99/MF A01 CSCL 22B

The space shuttle contaminant environment consisting of molecules and particles originating on the Shuttle is considered. The molecules come from outgassing, cabin leakage, flash evaporators and other man-controlled vents, and rocket exhaust. Particles are thought to come from abrasion, ablation of surfaces, dust trapped in cracks, dust from vents and cabin leaks, ice particles from improper venting, and droplets of unburned fuel. The effect of the infrared radiation from molecules and particles on a sensitive infrared telescope is emphasized. Infrared spectrum of H<sub>2</sub>O and CO<sub>2</sub> at fairly high resolution is discussed along with the spectrum and sighting frequency of particles spalled by micrometeoroids.  
J.M.S.

N79-25342# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**VORTEX SIMULATION OF THREE-DIMENSIONAL SPOT-LIKE DISTURBANCES IN A LAMINAR BOUNDARY LAYER**

A. Leonard May 1979 14 p refs Presented at 2d Symp. on Turbulent Shear Flows, London, Engl., 2-4 Jul. 1979  
(NASA-TM-78579; A-7789) Avail: NTIS HC A02/MF A01 CSCL 20D

The growth of a turbulent spot in a laminar boundary layer as the spot evolves from a localized disturbance in the layer, is simulated numerically using a three-dimensional vortex filament description of the vorticity field. The filaments are marked with a sequence of node points which are tracked in a Lagrangian reference frame. Velocity computation is done by Biot-Savart integration. Although some discrepancies with experiment appear to exist in the near wall region, the gross properties of the spot, including the velocities of the leading and trailing edges and the velocity perturbations away from the wall, are in good agreement with experiment.  
Author

N79-25951# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**INFRARED RECEIVERS FOR LOW BACKGROUND ASTRONOMY: INCOHERENT DETECTORS AND COHERENT DEVICES FROM ONE MICROMETER TO ONE MILLIMETER**  
Final Report:

N. W. Boggess (NASA, Washington), L. T. Greenberg (Aerospace Corp.), M. G. Hauser (NASA, Goddard Space Flight Center), J. R. Houck (Cornell Univ.), F. J. Low (Arizona Univ.), C. R. McCreight, D. M. Rank (California Univ., Santa Cruz), P. L. Richards (California

Jun., Berkeley), and R. Weiss (MIT) Jun. 1979 120 p refs  
(NASA-TM-78598; A-7874) Avail: NTIS HC A06/MF A01 CSCL 03A

The status of incoherent detectors and coherent receivers over the infrared wavelength range from one micrometer to one millimeter is described. General principles of infrared receivers are included, and photon detectors, bolometers, coherent receivers, and important supporting technologies are discussed, with emphasis on their suitability for low background astronomical applications. Broad recommendations are presented and specific opportunities are identified for development of improved devices.  
Author

N79-26715# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THE 1977 INTERTROPICAL CONVERGENCE ZONE EXPERIMENT**

I. G. Popoff, ed., W. A. Page, ed., and A. P. Margozzi, ed. Jun. 1979 493 p refs  
(NASA-TM-78577; A-7780) Avail: NTIS HC A21/MF A01 CSCL 04B

Data are presented from the 1977 Intertropical Convergence Zone (ITCZ) Experiment conducted in the Panama Canal Zone in July 1977. Measurements were made daily over a 16-day period when the ITCZ moved across the Canal Zone. Two aircraft (Learjet and U-2) flew daily and provided data from horizontal traverses at several altitudes to 21.3 km of ozone, temperature, pressure, water vapor, aerosols, fluorocarbons, methane, nitrous oxide, nitric oxide, and nitric acid. Balloons sondes flown four times per day provided data on ozone, wind fields, pressure, temperature, and humidities to altitudes near 30 km. Rocketsondes provided daily data to altitudes near 69 km. Satellite photography provided detailed cloud information. Descriptions of individual experiments and detailed compilations of all results are provided. For individual titles, see N79-26716 through N79-26729.

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N79-26717# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**OPERATIONAL ACTIVITIES**

William A. Page /n its The 1977 Intertrop. Convergence Zone Expt. Jun. 1979 p 5-12 (For primary document see N79-26715 17-47)

Avail: NTIS HC A21/MF A01 CSCL 04B

A short description of the observational field program as carried out in the Canal Zone during July 1977 is presented. The people responsible for organizing the activity and those deployed to the Canal Zone, who were responsible for various aspects of the field activity (including the experiments) are listed. The ozonesonde balloon and rocketsonde launches and the aircraft flight track are shown. The daily activity schedule during the 16-day Intertropical Convergence Zone study is shown. The instrument configuration of the U-2 research aircraft used during the experiment is also shown.  
G.Y.

N79-26720# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**MEASUREMENT OF NO AND O3 FROM AIRCRAFT: 1977 TROPICAL CONVERGENCE ZONE EXPERIMENT**

W. L. Starr, M. Loewenstein, and R. A. Craig /n its The 1977 Intertrop. Convergence Zone Expt. Jun. 1979 p 35-50 (For primary document see N79-26715 17-47)

Avail: NTIS HC A21/MF A01 CSCL 04B

As part of the Ames Research Center program to explore the nature of stratosphere-troposphere exchange processes occurring in the Intertropical Convergence Zone, simultaneous in situ measurements of nitric oxide and ozone mixing ratios were made with the Ames stratospheric air sampler SAS 2. The SAS 2 is a second-generation system; it employs four parallel sensors and was designed primarily for measurements at altitudes of 60,000 ft and above on the U-2 stratospheric research aircraft. The only modifications required for this study was the addition of an air sample flow restrictor. Data were obtained with the

SAS 2 system on July 26, 27, 30 and 31, 1977. Generally, 30-min measurements were made at each of six altitudes ranging from 45,000 ft to 70,000 ft, and separated by 5,000 ft intervals. G.Y.

**N79-26721\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**TRACE CONSTITUENT MIXING RATIOS IN THE LOWER STRATOSPHERE DURING THE 1977 INTERTROPICAL CONVERGENCE ZONE EXPERIMENT**

J. F. Vedder, C. O. Boitnott, B. J. Tyson, E. C. Y. Inn, and Dean Ohara (LFE Corp., Richmond, Calif.) *In its The 1977 Intertrop. Convergence Zone Expt. Jun. 1979 p 51-60* ref (For primary document see N79-26715 17-47)

Avail: NTIS HC A21/MF A01 CSCL 04B

Minor constituents in the atmosphere can play an important role as tracers in studies of atmospheric transport and mixing. Simultaneous measurements of the vertical distribution of trace constituents in the troposphere and lower stratosphere were conducted in the region of the Intertropical Convergence Zone (ITCZ). An effort was made to measure the mixing ratios of selected trace constituents. A cryogenic sampling system on board a U-2 aircraft was used to acquire whole-air samples and to cryogenically collect samples at 13.7 to 21.3 km. Simultaneous tropospheric measurements using whole-air sampling canisters on board a Learjet aircraft were also carried out. G.Y.

**N79-26725\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**STRATOSPHERIC AEROSOLS IN THE INTERTROPICAL CONVERGENCE ZONE, PANAMA CANAL ZONE**

Neil H. Farlow, Guy V. Ferry, Homer Y. Lem (LFE Corp., Richmond, Calif.), and Dennis M. Hayes (LFE Corp., Richmond, Calif.) *In its The 1977 Intertrop. Convergence Zone Expt. Jun. 1979 p 127-144* refs (For primary document see N79-26715 17-47)

Avail: NTIS HC A21/MF A01 CSCL 04B

To investigate whether injection sources of the stratospheric aerosol layer could be detected in the tropical stratosphere, an examination of the aerosol vertical and horizontal size distribution around the Intertropical Convergence Zone (ITCZ) at the Panama Canal Zone was performed during the summer of 1977. By comparing these data with similar measurements in temperate and polar regions, it was hoped to discover variations in particle size that would indicate whether a young aerosol is forming and entering the stratosphere at the ITCZ; where the aerosol matures, and finally, where it reenters the troposphere. The methods used in the investigations and the results obtained from the analyses are described. G.Y.

**N79-26727\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**AIRBORNE PRESSURE AND TEMPERATURE MEASUREMENTS DURING THE 1977 INTERTROPICAL CONVERGENCE ZONE EXPERIMENT**

Robert M. Munoz *In its The 1977 Intertrop. Convergence Zone Expt. Jun. 1979 p 153-164* refs (For primary document see N79-26715 17-47)

Avail: NTIS HC A21/MF A01 CSCL 04B

During the 1977 ITCZ (Intertropical Convergence Zone) experiment in Panama two aircraft and numerous balloon-borne radiosonde instruments were equipped to measure pressure and temperature. The experiment was a coordinated effort to evaluate the meteorological conditions that prevailed from July 17 through 31, 1977. A critical analysis of the data collected on one of the aircraft (the Lear jet) operating at altitudes to 13,000 m for about 2 hr each day during most days of the experiment is presented. The discussion includes a comparison of the vertical profiles of potential temperature obtained from the Learjet with those obtained from balloons launched at Ft. Sherman. Time histories of pressure, temperature, and potential temperature, as observed from the Learjet are also presented. G.Y.

**N79-26728\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PRESSURE AND TEMPERATURE MEASUREMENTS FROM THE U-2 AIRCRAFT DURING THE 1977 INTERTROPICAL CONVERGENCE EXPERIMENT**

James F. Vedder *In its The 1977 Intertrop. Convergence Zone Expt. Jun. 1979 p 165-174* ref (For primary document see N79-23715 17-47)

Avail: NTIS HC A21/MF A01 CSCL 04B

For the study of the Intertropical Convergence Zone, the aircraft provided pressure and temperature data to supplement the radiosonde records. The results obtained from the U-2 aircraft during the six nights of the cryogenic and whole-air sampling system on July 18, 19, 23, 25, 28, and 29, 1977, are presented. G.Y.

**N79-27241\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PHOTOSENSITIZED OXIDATION OF UNSATURATED POLYMERS**

Morton A. Golub Jun. 1979 22 p refs (NASA-TM-78604: A-7891) Avail: NTIS HC A02/MF A01 CSCL 07C

The photosensitized oxidation or singlet oxygenation of unsaturated hydrocarbon polymers and of their model compounds was reviewed. Emphasis was on cis and trans forms of 1,4-polyisoprene, 1,4-polybutadiene and 1,2-poly(1,4-hexadiene), and on 1,4-poly(2,3-dimethyl-1,3-butadiene). The microstructural changes which occur in these polymers on reaction with O<sub>2</sub>-1 in solution were investigated by infrared H-1 and C-13 NMR spectroscopy. The polymers were shown to yield allylic hydroperoxides with shifted double bonds according to the ene mechanism established for simple olefins. The photosensitized oxidation of the above unsaturated polymer exhibited zero order kinetics, the relative rates paralleling the reactivities of the corresponding simple olefins towards O<sub>2</sub>-1. Author

**N79-27243\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**EFFECTS OF MOISTURE ON TORSION AND FLEXURE PROPERTIES OF GRAPHITE-EPOXY COMPOSITES**

H. T. Sumsion and M. J. Adamson Jun. 1979 27 p refs (NASA-TM-78597: A-7E68) Avail: NTIS HC A02/MF A01 CSCL 11D

The effects of moisture and temperature on unidirectional and multi-ply laminates of T300/934 and AS/3501 graphite-epoxy systems were investigated. Properties studied were static flexure strength, and flexure and torsion fatigue strengths at room temperature and at 74 C. Specimens with increased moisture content showed a reduced static flexure strength; water as the test environment had only a negligible influence. In flexure fatigue and torsion fatigue, the water environment caused somewhat reduced fatigue strengths at room temperature and significantly greater degradation in 74 C water. The failure mode in all cases was interlaminar delamination. Author

**N79-28850\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**LIFE TESTING OF MALLORY CELLS**

Duane Dugan *In NASA Goddard Space Flight Center 11th Ann. Battery Workshop 1978 p 489-497* (For primary document see N79-28669 19-44)

Avail: NTIS HC A23/MF A01 CSCL 10C

Tests were performed to assess the effects of storage time, storage temperature, vibration, discharge rate and temperature, and capacity of high-rate, D size, lithium sulfur dioxide cells. Data from these tests are discussed. G.Y.

**N79-28850\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**FLUX VECTOR SPLITTING OF THE INVISCID EQUATIONS**

**WITH APPLICATION TO FINITE DIFFERENCE METHODS**  
Joseph L. Steger and R. F. Warming Jul. 1979 54 p refs  
(NASA-TM-78605: A-7893) Avail: NTIS HC A04/MF A01  
CSCL 12A

The conservation-law form of the inviscid gasdynamic equations has the remarkable property that the nonlinear flux vectors are homogeneous functions of degree one. This property readily permits the splitting of flux vectors into subvectors by similarity transformations so that each subvector has associated with it a specified eigenvalue spectrum. As a consequence of flux vector splitting, new explicit and implicit dissipative finite-difference schemes are developed for first-order hyperbolic systems of equations. Appropriate one-sided spatial differences for each split flux vector are used throughout the computational field even if the flow is locally subsonic. The results of some preliminary numerical computations are included. Author

**N79-30146\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**INVESTIGATION OF THE ASYMMETRIC AERODYNAMIC CHARACTERISTICS OF CYLINDRICAL BODIES OF REVOLUTION WITH VARIATIONS IN NOSE GEOMETRY AND ROTATIONAL ORIENTATION AT ANGLES OF ATTACK TO 58 DEGREES AND MACH NUMBERS TO 2**

Robert L. Kruse, Earl R. Keener, Gary T. Chapman, and Gary Claser (ARO, Inc., Moffett Field, Calif.) Sep. 1979 98 p  
(NASA-TM-78533: A-7640) Avail: NTIS HC A05/MF A01  
CSCL 01A

Wind-tunnel tests were conducted to investigate the side forces and yawing moments that can occur at high angles of attack and zero sideslip for cylindrical bodies of revolution. Two bodies having several tangent ogive forebodies with fineness ratios of 0.5, 1.5, 2.5, and 3.5 were tested. The forebodies with fineness ratios of 2.5 and 3.5 had several bluntnesses. The cylindrical afterbodies had fineness ratios of 7 and 13. The model components - tip, forebody, and afterbody - were tested in various rotational positions about their axes of symmetry. Most of the tests were conducted at a Mach number of 0.25, a Reynolds number of  $0.32 \times 10^6$  to the 6th power, and with the afterbody that had a fineness ratio of 7 and with selected forebodies. The effect of Mach number was determined with the afterbody that had a fineness ratio of 13 and with selected forebodies at mach numbers from 0.25 to 2 at Reynolds number =  $0.32 \times 10^6$  to the 6th power. Maximum angle of attack was 58 deg. Author

**N79-31176\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PROGRAMS FOR CALCULATING CELL PARAMETERS IN ELECTRON AND X-RAY DIFFRACTION**  
George Polkowski (LFE Corp., Richmond, Calif.), K. G. Snelssinger, and Neil H. Farlow Aug. 1979 57 p refs  
(NASA-TP-1529: A-7761) Avail: NTIS HC A04/MF A01 CSCL 13B

Ten programs for calculating cell parameters from single crystal electron diffraction patterns are presented. Most of the programs, written for use with a programmable desk calculator, are also applicable to X-ray diffraction work. The programs can be used to calculate d-spacings from electron diffraction plate measurements, and to determine cell data (including interplanar angles and zone angles) for all crystal systems. A program for rhombohedral-hexagonal conversions and one for matching crystal data from standards with apparent crystal parameters found in diffraction patterns are included. Because they allow rapid determination of data not present in X-ray listings or elsewhere in the literature, the programs facilitate identification of unknowns. K.L.

**N79-31166\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**CONFERENCE ON FIRE RESISTANT MATERIALS: A COMPILATION OF PRESENTATIONS AND PAPERS**  
Demetrius A. Kourides, ed. and Gerald A. Johnson, ed (Boeing

Com. Airplane Co., Seattle, Wash.) Jul. 1979 287 p Conf. held in Seattle, 1-2 Mar. 1979  
(NASA-CP-2094: A-7894) Avail: NTIS HC A13/MF A01 CSCL 01C

The proceedings of the NASA IRE Resistant Materials Engineering (FIREMEN) Program held at Boeing Commercial Airplane Company, Seattle, Washington, on March 1-2, 1979 are reported. The conference was to discuss the results of research by the National Aeronautics and Space Administration in the field of aircraft fire safety and fire-resistant materials. The program topics include the following: (1) large-scale testing; (2) fire toxicology; (3) polymeric materials; and (4) fire modeling. For individual titles, see N79-31167 through N79-31183.

**N79-31176\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**FIRE RESISTANT AIRCRAFT SEAT PROGRAM**

Larry A. Fewell In its Conf. on Fire Resistant Mater. Jul. 1979 p 135-166 (For primary document see N79-31166 22-03)  
Avail: NTIS HC A13/MF A01 CSCL 01C

Foams, textiles, and thermoformable plastics were tested to determine which materials were fire retardant, and safe for aircraft passenger seats. Seat components investigated were the decorative fabric cover, slip covers, fire blocking layer, cushion reinforcement, and the cushioning layer. F.O.S.

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**N79-31179\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**ADVANCED RESIN MATRICES FOR COMPOSITES**

Demetrius A. Kourides In its Conf. on Fire Resistant Mater. Jul. 1979 p 223-238 (For primary document see N79-31166 22-03)  
Avail: NTIS HC A13/MF A01 CSCL 01C

The selection criteria, and the chemical structure of resin matrices are given along with the processing conditions for resins and laminates. F.O.S.

**N79-31353\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THERMAL EXPANSION AND SWELLING OF CURED EPOXY RESIN USED IN GRAPHITE/EPOXY COMPOSITE**

Michael J. Adamson Sep. 1979 35 p refs  
(NASA-TM-78610: A-7919) Avail: NTIS HC A03/MF A01 CSCL 11D

The thermal expansion and swelling of resin material as influenced by variations in temperature during moisture absorption is discussed. Comparison measurements using composites constructed of graphite fibers and each of two epoxy resin matrices are included. Polymer theory relative to these findings is discussed and modifications are proposed. A.W.H.

**N79-31528\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**A NAVIER-STOKES FAST SOLVER FOR TURBULENT MODELING APPLICATIONS**

J. D. Murphy and M. W. Rubesin Aug. 1979 19 p refs  
Presented at AGARD Conf. on Turbulent Boundary Layers: Expt., Theory, and Modeling, Hague, 25-26 Sep. 1979  
(NASA-TM-78612: A-7936) HC A02/MF A01 CSCL 20D

A computer program for the solution of the steady Reynolds averaged incompressible Navier-Stokes equations that can accept a variety of turbulence closure models is described. The program is sufficiently accurate and economical to permit extensive comparisons with mean moment data from experiment and should provide a useful tool to the turbulence modeler because of the generality of the models which can be considered and the economy with which solutions can be obtained. Focus is on 0, 1, and 2 equation closure models and the computed results are compared with experiment and with results of boundary-layer

calculation using the same models. These comparisons show that flow parameters which are sufficiently severe to provide strong tests of higher order closure models are also sufficiently severe as to cast doubt on the results based on classical boundary-layer calculations. To demonstrate the accuracy and speed of the program, parametric studies are presented which show the effects of both purely numerical considerations, such as mesh size, convergence criteria, boundary location, etc., and physical consideration such as boundary conditions, etc. It is believed that the present computer code is more general than previously available fast solvers. No near-wall equilibrium assumptions have to be made, as both the mean flow and turbulence closure relations are integrated all the way to the wall.

A.R.H.

**N79-32152\***# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**LARGE EDDY SIMULATION OF TURBULENT CHANNEL FLOW: ILLIAC 4 CALCULATION**

John Kim and Parviz Moin Sep. 1979 21 p refs Presented at AGARD Symp. on Turbulent Boundary Layer - Experiment, Theory, and Modelling, The Hague, Netherlands, 24-27 Sep. 1979

(NASA-TM-78619: A-7952) Avail: NTIS HC A02/MF A01 CSCL 02A

The three-dimensional time dependent equations of motion were numerically integrated for fully-developed turbulent channel flow. A large scale flow field was obtained directly from the solution of these equations, and small scale field motions were simulated through an eddy viscosity model. The calculations were carried out on the ILLIAC 4 computer. The computed flow patterns show that the wall layer consists of coherent structures of low speed and high speed streaks alternating in the spanwise direction. These structures were absent in the regions away from the wall. Hot spots, small localized regions of very large turbulent shear stress, were frequently observed. The profiles of the pressure velocity-gradient correlations show a significant transfer of energy from the normal to the spanwise component of turbulent kinetic energy in the immediate neighborhood of the wall ('the splatting effect').

R.E.S.

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**N79-32241\***# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**MINING AND BENEFICIATION OF LUNAR ORES**

c91

Theodore E. Bunch, Richard J. Williams (NASA, Johnson Space Center), David S. McKay (NASA, Johnson Space Center), and David Giles (Rio Amex Corp.) *In its Space Resources and Space Settlements* 1979 p 275-288 refs (For primary document see N79-32225 23-12)

Avail: NTIS MF A01 SOD HC CSCL 03B

The beneficiation of lunar plagioclase and ilmenite ores to feedstock grade permits a rapid growth of the space manufacturing economy by maximizing the production rate of metals and oxygen. A beneficiation scheme based on electrostatic and magnetic separation is preferred over conventional schemes, but such a scheme cannot be completely modeled because beneficiation processes are empirical and because some properties of lunar minerals have not been measured. To meet anticipated shipping and processing needs, the peak lunar mining rate will exceed 1000 tons/hr by the fifth year of operation. Such capabilities will be best obtained by automated mining vehicles and conveyor systems rather than trucks. It may be possible to extract about 40 kg of volatiles (60 percent H<sub>2</sub>O) by thermally processing the less than 20 micron ilmenite concentrate extracted from 130 tons of ilmenite ore. A thermodynamic analysis of an extraction process is presented.

Author

Author

**N79-32265\***# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**RELEASE-RATE CALORIMETRY OF MULTILAYERED MATERIALS FOR AIRCRAFT SEATS**

L. L. Fewell, Fred Duskin (McDonnell Douglas Aircraft Co., Long

Beach, Calif.), Howard Spieth (McDonnell Douglas Aircraft Co., Long Beach, Calif.), Ed Trabold (McDonnell Douglas Aircraft Co., Long Beach, Calif.), and J. A. Parker Aug. 1979 26 p refs (NASA-TM-78594: A-7856) Avail: NTIS HC A03/MF A01 CSCL 11G

Multilayered samples of contemporary and improved fire resistant aircraft seat materials (foam cushion, decorative fabric, slip sheet, fire blocking layer, and cushion reinforcement layer) were evaluated for their rates of heat release and smoke generation. Top layers (decorative fabric, slip sheet, fire blocking, and cushion reinforcement) with glass fiber block cushion were evaluated to determine which materials based on their minimum contributions to the total heat release of the multilayered assembly may be added or deleted. Top layers exhibiting desirable burning profiles were combined with foam cushion materials. The smoke and heat release rates of multilayered seat materials were then measured at heat fluxes of 1.5 and 3.5 W/sq cm. Choices of contact and silicone adhesives for bonding multilayered assemblies were based on flammability, burn and smoke generation, animal toxicity tests, and thermal gravimetric analysis. Abrasion tests were conducted on the decorative fabric covering and slip sheet to ascertain service life and compatibility of layers.

Author

**N79-33433\***# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**DEVELOPMENTS IN THE COMPUTATION OF TURBULENT BOUNDARY LAYERS**

Morris W. Rubesin Washington Sep. 1979 26 p refs Presented at AGARD Symp. on Turbulent Boundary Layer - Experiment, Theory and Modelling, The Hague, 24-27 Sep. 1979 (NASA-TM-78620: A-7953) Avail: NTIS HC A03/MF A01 CSCL 20D

Computational techniques applicable to turbulent boundary layers are classified into solutions of Reynolds-averaged equations, in which all the effects of the turbulence are modelled, and solutions of three-dimensional, time dependent Navier-Stokes equations, in which the large eddies are calculated and only the turbulence at scales smaller than the computational mesh spacings has to be modelled. Current computation costs place engineering computations in the first of these categories; large eddy simulations are appropriate currently for special studies of the dynamical processes of turbulence in idealized flow fields. It is shown that the two methods are interrelated and that each can gain from advances in the other. The degree of success of a pair of increasingly complex Reynolds stress models to broaden their range of applicability is examined through comparisons with experimental data for a variety of flow conditions. An example of a large-eddy simulation is presented, compared with experimental results, and used to evaluate the models for pressure rate-of-strain correlations and dissipation in the Reynolds-averaged equations.

Author

## NASA CONTRACTOR REPORTS

**N79-10144\***# Ultrasystems, Inc., Irvine, Calif.

**PREPARATION OF LINEAR HYDROXY SUBSTITUTED POLYPHOSPHAZENES** Final Report

K. L. Paciorek, T. I. Ito, and R. H. Kratzer Oct. 1978 40 p refs

(Contract NAS2-8469)

(NASA-CR-152182: SN-8275-F) Avail: NTIS HC A03/MF A01 CSCL 07C

The synthesis of partially hydroxy-substituted phosphazene prepolymers amenable to processing into cellular, flexible polyurethane foams was investigated. Factors determined include (1) the environment of the hydroxyl group; (2) the ease of the hexachlorocyclotriphosphazene polymerization; (3) the nature of the nonreactive substituents; and (4) the mode of introduction of the hydroxyl entity. The specific approaches taken, the rationale of the selections made, and the results are discussed.

A.R.H.

N79-10378# Nielsen Engineering and Research, Inc., Mountain View, Calif.

**METHODS OF SEPARATION OF VARIABLES IN TURBULENCE THEORY Final Report**

Shunichi Tsuge Oct. 1978 66 p refs  
(Contract NAS2-9535)

(NASA-CR-3054: NEAR-TR-137) Avail: NTIS  
HC A04/MF A01 CSCL 20D

Two schemes of closing turbulent moment equations are proposed both of which make double correlation equations separated into single-point equations. The first is based on neglected triple correlation, leading to an equation differing from small perturbed gasdynamic equations where the separation constant appears as the frequency. Grid-produced turbulence is described in this light as time-independent, cylindrically-isotropic turbulence. Application to wall turbulence guided by a new asymptotic method for the Orr-Sommerfeld equation reveals a neutrally stable mode of essentially three dimensional nature. The second closure scheme is based on an assumption of identity of the separated variables through which triple and quadruple correlations are formed. The resulting equation adds, to its equivalent of the first scheme, an integral of nonlinear convolution in the frequency describing a role due to triple correlation of direct energy-cascading.

Author

N79-10971# Analytical Decisions, Inc., Arlington, Va.  
**ASSESSMENT STUDY OF INFRARED DETECTOR ARRAYS FOR LOW-BACKGROUND ASTRONOMICAL RESEARCH Final Technical Report**  
K. J. Ando Aug. 1978 98 p refs  
(Contract NAS2-9858)  
(NASA-CR-152169) Avail: NTIS HC A05/MF A01 CSCL 03A

The current state-of-the-art of infrared detector arrays employing charge coupled devices (CCD), or charge injection devices (CID) readout are assessed. The applicability, limitations and potentials of such arrays under the low-background astronomical observing conditions of interest for SIRFT (Shuttle Infrared Telescope Facility) are determined. The following are reviewed: (1) monolithic extrinsic arrays; (2) monolithic intrinsic arrays; (3) charge injection devices; and (4) hybrid arrays. G.Y.

N79-12048# Douglas Aircraft Co., Inc., Long Beach, Calif.  
**STUDY TO DEVELOP IMPROVED FIRE RESISTANT AIRCRAFT PASSENGER SEAT MATERIALS, PHASE 2 Final Technical Report, 20 Sep. 1977 - 30 Jun. 1978**  
Fred E. Duskin, William H. Shook, Edward L. Trabold, and Howard H. Spieth [1978] 379 p refs  
(Contract NAS2-9337)  
(NASA-CR-152184) Avail: NTIS HC A17/MF A01 CSCL 01C

Fire tests are reported of improved materials in multilayered combinations representative of cushion configurations. Tests were conducted to determine their thermal, smoke, and fire resistance characteristics. Additionally, a source fire consisting of one and one-half pounds of newspaper in a tented configuration was developed. Finally, a preliminary seat specification was written based upon materials data and general seat design criteria. G.G.

N79-12151# Boeing Commercial Airplane Co., Seattle, Wash.  
**DEVELOPMENT OF AIRCRAFT LAVATORY COMPARTMENTS WITH IMPROVED FIRE RESISTANCE CHARACTERISTICS, PHASE 1: FIRE CONTAINMENT TEST OF A WIDE BODY AIRCRAFT LAVATORY MODULE Final Report**  
R. A. Anderson, D. B. Arnold, G. A. Johnson, and E. A. Tustin Jul. 1978 84 p  
(Contract NAS2-8700)  
(NASA-CR-152074: D6-44885) Avail: NTIS  
HC A05/MF A01 CSCL 11D

A test was conducted to evaluate the fire containment characteristics of a Boeing 747 lavatory module. Results showed that the fire was contained within the lavatory during the

30-minute test period with the door closed. The resistance of the lavatory wall and ceiling panels and general lavatory construction to burn-through under the test conditions was demonstrated.

Author

N79-12772# Illinois Univ. at Urbana-Champaign, Urbana Coordinated Science Lab.

**ADAPTIVE ALLOCATION OF DECISION MAKING RESPONSIBILITY BETWEEN HUMAN AND COMPUTER IN MULTI-TASK SITUATIONS Ph.D. Thesis**

Yee-yeen Chu Sep. 1978 150 p refs  
(Grant NsG-2219)

(NASA-CR-157937: T-66) Avail: NTIS HC A07/MF A01 CSCL 09B

A unified formulation of computer-aided, multi-task, decision making is presented. Strategy for the allocation of decision making responsibility between human and computer is developed. The plans of a flight management systems are studied. A model based on the queueing theory was implemented.

S.E.S.

N79-14887# Arizona Univ., Tucson. Engineering Experiment Station.

**A NEW METHOD FOR DESIGNING SHOCK-FREE TRANSONIC CONFIGURATIONS**

H. Sobieczky, K-Y. Fung, A. R. Seebass, and N. J. Yu Jul. 1978 35 p refs Presented at the AIAA 11th Fluid and Plasma Dyn. Conf., Seattle, 10-12 Jul. 1978  
(Grant NsG-2112; Contract N00014-76-C-0182; Grant AF-AFOSR-2954E-76)

(NASA-CR-158063: Paper-78-114; TED-78-04) Avail: NTIS HC A03/MF A01 CSCL 01A

A method for the design of shock free supercritical airfoils, wings, and three dimensional configurations is described. Results illustrating the procedure in two and three dimensions are given. They include modifications to part of the upper surface of an NACA 64A410 airfoil that will maintain shock free flow over a range of Mach numbers for a fixed lift coefficient, and the modifications required on part of the upper surface of a flat wing with an NACA 64A410 root section to achieve a shock free flow. While the results are given for inviscid flow, the procedures can be employed iteratively with a boundary layer calculation in order to achieve shock free viscous designs. With a shock free pressure field the boundary layer calculation will be reliable and not complicated by the difficulties of shock wave boundary layer interaction.

Author

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N79-16472# Texas Univ., Galveston. Geophysics Lab.

**FIELD MEASUREMENT OF PENETRATOR SEISMIC COUPLING IN SEDIMENTS AND VOLCANIC ROCKS**

Yosio Nakamura, Gary V. Latham, and Cliff Frohlich Jan. 1979 62 p refs  
(Grant NsG-2310)

(NASA-CR-158081: Contrib-316) Avail: NTIS HC A04/MF A01 CSCL 08G

Field experiments were conducted to determine experimentally how well a seismometer installed using a penetrator would be coupled to the ground. A dry lake bed and a lava bed were chosen as test sites to represent geological environments of two widely different material properties. At each site, two half-scale penetrators were fired into the ground, a three-component geophone assembly was mounted to the aft end of each penetrator, and dummy penetrators were fired at various distances to generate seismic signals. The recorded signals were digitized, and cross-spectral analyses were performed to compare the observed signals in terms of power spectral density ratio, coherence and phase difference. The analyses indicate that seismometers deployed by penetrators will be as well coupled to the ground as are seismometers installed by conventional methods for the frequency range of interest in earthquake seismology, although some minor differences were observed at frequencies near the upper limit of the frequency band.

N79-18875# California Univ., Berkeley.

**AETHER DRIFT AND THE ISOTROPY OF THE UNIVERSE:  
A MEASUREMENT OF ANISOTROPIES IN THE PRIMORDIAL BLACK-BODY RADIATION Final Report, 1 Oct.  
1977 - 30 Sep. 1978**

Richard A. Muller 23 Feb. 1979 46 p refs  
(Grant NsG-2125)

(NASA-CR-158129; SSL-SER-20-Issue-10) Avail: NTIS  
HC A03/MF A01 CSCL 03B

This experiment detected and mapped large-angular-scale anisotropies in the 3 K primordial black-body radiation with a sensitivity of  $2 \times 0.001$  k and an angular resolution of about 10 degs. It measured the motion of the Earth with respect to the distant matter of the Universe (Aether Drift), and probed the homogeneity and isotropy of the Universe (the Cosmological Principle). The experiment used two Dicke radiometers, one at 33 GHz to detect the cosmic anisotropy, and one at 54 GHz to detect anisotropies in the residual oxygen above the detectors. The system was installed in the NASA-Ames Earth Survey Aircraft (U-2), and operated successfully in a series of flights. L

N79-19088# Martin Marietta Corp., Denver, Colo.

**STUDY OF ALTERNATIVE PROBE TECHNOLOGIES  
Final Report**

Dec. 1977 196 p refs  
(Contract NAS2-9835)  
(NASA-CR-152242, MCR-77-311) Avail: NTIS  
HC A09/MF A01 CSCL 22B

A number of implied technologies for a deep probe mission was examined; i.e., one that would provide the capability to scientifically examine planetary atmospheres at the 1000 bar level. Conditions imposed by current Jupiter, Saturn, and Uranus atmospheric models were considered. The major thrust of the measurements was to determine lower atmosphere composition, even to trace constituents of one part per billion. Two types of instruments having the necessary accuracy to meet the science objectives were considered and integrated into a deep probe configuration. One deep probe option that resulted was identified as a Minimum Technology Development approach. The significant feature of this option is that only three technology developments are required to enable the mission, i.e., (1) science instrument development, (2) advanced data processing, and (3) external high pressure/thermal insulation. It is concluded that a probe designed for a Jupiter mission could, with minor changes, be used for a Saturn or Uranus mission. Author

Oct. 1978 - Mar. 1978

Lawrence Fox, III, Principal Investigator 1978 43 p ERTS  
(Grant NsG-2341)  
(E79-10168; NASA-CR-158164) Avail: NTIS  
HC A03/MF A01 CSCL 03B

There are no author-identified significant results in this report.

N79-21965# Grumman Aerospace Corp., Bethpage, N.Y.  
**AN ANALYSIS OF WATER IN GALACTIC INFRARED  
SOURCES USING THE NASA LEAR AIRBORNE OB-  
SERVATORY Final Report, 2 Jan. 1978 - 31 Mar. 1978**  
Lewis L. Smith and Theodorz Hilgeman Mar. 1978 81 p  
refs  
(Contract NAS2-8684)

(NASA-CR-152262; RM-884) Avail: NTIS HC A05/MF A01  
CSCL 03A

The Michelson interferometer system on the NASA Lear Jet Airborne Observatory is described as well as the data reduction procedures. The objects observed (standard stars, M stars, a nebula, planets, and the moon) are discussed and the observing parameters are listed for each flight date. The spectra obtained from these data flights are presented, grouped by class of object. A.R.H.

N79-22137# McDonnell-Douglas Astronautics Co., St. Louis,  
Mo.

**OPTIMIZED COST/PERFORMANCE DESIGN METHODOLOGY. VOLUME 2: DATA REVIEW AND ANALYSIS.  
BOOK 5: COST**

c16  
In Von Karman Inst. for Fluid Dyn. Technol. of Space Shuttle Vehicles, Vol. 2 1970 208 p refs (For primary document see N79-  
22130 13-12)

(Contract NAS2-5022)

Avail: NTIS HC A22/MF A01 CSCL 22B

The broad objectives of the study were to gather historical cost and performance data, organize and analyze the data so that cost estimating relationships could be developed, and evaluate several system concepts for space logistics support. The primary source of historical cost data was the Gemini and Saturn Programs and cost estimating relationships drew extensively on this experience. A range of reuse concepts were evaluated and optimum (least cost) concepts defined for a variety of program options. These include variations in such things as crew size, cargo capacity, program requirements, etc for either ballistic or lifting body (M2-F2) entry vehicles. Author

N79-19082# Chicago Univ., Ill.

**FAR INFRARED MAPS OF THE RIDGE BETWEEN OMC-1  
AND OMC-2 Final Technical Report**

Jocelyn Keene, J. Smith, D. A. Harper, R. H. Hildebrand, and S. E. Whitcomb Mar. 1979 19 p refs  
(Grant NsG-2261)  
(NASA-CR-158235) Avail: NTIS HC A02/MF A01 CSCL 03A

Dust continuum emission from a 6 ft x 20 ft region surrounding OMC-1 and OMC-2 were mapped at 55 and 125 microns with 4 ft resolution. The dominant features of the maps are a strong peak at OMC-1 and a ridge of lower surface brightness between OMC-1 and OMC-2. Along the ridge the infrared flux densities and the color temperature decreases smoothly from OMC-1 to OMC-2. OMC-1 is heated primarily by several optical and infrared stars situated within or just at the boundary of the cloud. At the region of minimum column density between OMC-1 and OMC-2 the nearby B0.5 V star NU Ori may contribute significantly to the dust heating. Near OMC-2 dust column densities are large enough so that, in addition to the OMC-2 infrared cluster, the nonlocal infrared sources associated with OMC-1 and NU Ori can contribute to the heating. G.Y.

N79-23568# Control Data Corp., Minneapolis, Minn. Research  
and Advanced Design Lab.

**STUDIES OF STRATOSPHERIC EDDY TRANSPORT. 1: THE  
OBSERVED OZONE FLUX BY THE TRANSIENT EDDIES,  
0-30 KM. 2: EDDY DIFFUSION COEFFICIENTS AND WIND  
STATISTICS, 30-60 KM Final Report, 2 May 1977 - 30 Sep.  
1978**

G. D. Nastrom, D. E. Brown, and R. W. Wilcox 29 Sep. 1978  
94 p refs  
(Contract NAS2-9578)  
(NASA-CR-158617, AD-A065616; AFGL-TR-78-0311) Avail:  
NTIS HC A05/MF A01 CSCL 04/1

In Part I, Ozonesonde data were matched with concomitant rawinsonde data to provide a direct determination of meridional flux of ozone by transient eddies. Data are from about 25 stations in eastern and western North America, western Europe, and Japan. Results generally confirm the existence of significant northward flux, 10-18 km, in winter/spring; however, areas of significant equatorward flux have been found at high mid-latitudes, 10-16 km, over North America in winter/spring and at all latitudes, 10-18 km, over Japan in spring. Fluxes are typically small in summer, as well as throughout the troposphere, and throughout most of the middle stratosphere. Qualitative statements are made concerning the relative importance of mean meridional and standing eddy fluxes. Rocketsonde data, 30-60 km, 1961-1976.

N79-20438# Humboldt State Univ., Arcata, Calif. School of  
Natural Resources.

**THE APPLICATION OF REMOTE SENSING TECHNOLOGY  
IN NORTHERN CALIFORNIA Semiannual Progress Report,**

are the data base used for the three components of the eddy diffusion matrix and circulation statistics. Horizontal diffusivities are obtained from the variance of the meridional wind and the meridional wind's integral time scale. The present results are generally smaller than past estimates, presumably because temporal variations longer than a month were filtered out in this work. Estimates of K<sub>xy</sub> are based on the tentative assumption that the diffusivity is proportional to the slope of the isentropic surfaces.

GRA

**N79-23868#** Martin Marietta Corp., Denver, Colo.  
**STUDY OF ENTRY AND LANDING PROBES FOR EXPLORATION OF TITAN Final Report**

31 Mar. 1979 213 p  
(Contract NAS2-9985)  
(NASA-CR-152275) MCR-79-512 Avail: NTIS HC A10/MF A01 CSCL 14B

Saturn's largest moon, Titan, is a totally unique planetary body which is certain to yield exciting new phenomena. Current information is lacking in detail to distinguish between a thin methane rich atmosphere and a thick nitrogen rich atmosphere. Therefore, both the thin and thick atmospheric models were used for the study of various Titan probe classes described in this report. The technical requirements, conceptual design, science return, schedule, cost and mission implications of three probe classes that could be used for exploration of Titan are defined. The three probe classes were based on a wide range of exploration mission possibilities.

G.Y.

**N79-24298#** Grumman Aerospace Corp., Bethpage, N.Y.  
**DESIGN, FABRICATION AND TEST OF A HYDROGEN HEAT PIPE Final Report**

J. Alario Feb 1979 76 p refs  
(Contract NAS2-9291)  
(NASA-CR-152267) Avail: NTIS HC A05/MF A01 CSCL 20D

Re-entrant groove technology was extended to hydrogen heat pipes. Parametric analyses are presented which optimize the theoretical design while considering the limitations of state-of-the-art extrusion technology. The 6063-T6 aluminum extrusion is 14.6 mm OD with a wall thickness of 1.66 mm and contains 20 axial grooves which surround a central 9.3 mm diameter vapor core. Each axial groove is 0.775 mm diameter with a 0.33 mm opening. An excess vapor reservoir is provided at the evaporator to minimize the pressure containment hazard during ambient storage. Modifications to the basic re-entrant groove profile resulted in improved overall performance. While the maximum heat transport capacity decreased slightly to 103 w·m⁻¹ the static wicking height increased markedly to 4.5 cm. The heat pipe became operational between 20 and 30 K after a cooldown from 77 K without any difficulty. Steady state performance data taken over a 19 to 23 K temperature range indicated: (1) maximum heat transport capacity of 5.4 w·m⁻¹; (2) static wicking height of 1.42 cm, and (3) overall heat pipe conductance of 1.7 watts/deg C.

A.R.H.

**N79-25230#** Celanese Research Co., Summit, N.J.  
**ULTRATHIN METALLIZED PBI PAPER Final Report**

Edward C. Chenevey Dec. 1978 48 p  
(Contract NAS2-9526)  
(NASA-CR-152281) Avail: NTIS HC A03/MF A01 CSCL 07D

A study to determine the feasibility of preparing ultrathin papers with a target weight of 3.5 g/m² squared from polybenzimidazole (PBI) fibrils was undertaken. Small hand sheets of target weight were fabricated. They were light brown, low density materials with sufficient strength to be readily handleable. Characterization of these sheets included strength, fold endurance, thermal gravimetric analysis in air and nitrogen and photomicrographs. Two different batches of PBI fibrils were studied and differences in fabrication performance were noted. In neither case could target weight papers be prepared using conventional paper making techniques.

M.M.M.

**N79-26067#** Control Data Corp., St. Paul, Minn. Research and Advanced Design Lab.

**FEASIBILITY STUDY FOR A NUMERICAL AERODYNAMIC SIMULATION FACILITY: SUMMARY Final Report**

N. R. Lincoln May 1979 24 p 4 Vol.

(Contract NAS2-9896)

(NASA-CR-152286) Avail: NTIS HC A02/MF A01 CSCL 14B

The Ames Research Center of NASA is engaged in the development and investigation of numerical methods and computer technologies to be employed in conjunction with physical experiments, particularly utilizing wind tunnels in the furtherance of the field of aircraft and aerodynamic body design. Several studies, aimed primarily at the areas of development and production of extremely high-speed computing facilities, were conducted. The studies focused on evaluating the aspects of feasibility, reliability, costs, and practicability of designing, constructing, and bringing into effect production of a special-purpose system. An executive summary of the activities for this project is presented in this volume.

G.Y.

**N79-26068#** Control Data Corp., St. Paul, Minn. Research and Advanced Design Lab.

**FEASIBILITY STUDY FOR A NUMERICAL AERODYNAMIC SIMULATION FACILITY. VOLUME 1 Final Report**

N. R. Lincoln, R. O. Bergman, D. B. Bonstrom, T. W. Brinkman, S.-H. J. Chiu, S. S. Green, S. D. Hansen, D. L. Klein, H. E. Krohn, and R. P. Prow May 1979 626 p refs 4 Vol.

(Contract NAS2-9896)

(NASA-CR-152287) Avail: NTIS HC A99/MF A01 CSCL 14B

A Numerical Aerodynamic Simulation Facility (NASF) was designed for the simulation of fluid flow around three-dimensional bodies, both in wind tunnel environments and in free space. The application of numerical simulation to this field of endeavor promised to yield economies in aerodynamic and aircraft body designs. A model for a NASF/FMP (Flow Model Processor) ensemble using a possible approach to meeting NASF goals is presented. The computer hardware and software are presented, along with the engine design and performance analysis and evaluation.

G.Y.

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**N79-26089#** Control Data Corp., St. Paul, Minn. Research and Advanced Design Lab.

**FEASIBILITY STUDY FOR A NUMERICAL AERODYNAMIC SIMULATION FACILITY. VOLUME 2: HARDWARE SPECIFICATIONS/DESCRIPTIONS Final Report**

F. M. Green and D. R. Resnick May 1979 474 p 4 Vol.

(Contract NAS2-9896)

(NASA-CR-152288) Avail: NTIS HC A20/MF A01 CSCL 14B

An FMP (Flow Model Processor) was designed for use in the Numerical Aerodynamic Simulation Facility (NASF). The NASF was developed to simulate fluid flow over three-dimensional bodies in wind tunnel environments and in free space. The facility is applicable to studying aerodynamic and aircraft body designs. The following general topics are discussed in this volume: (1) FMP functional computer specifications; (2) FMP instruction specification; (3) standard product system components; (4) loosely coupled network (LCN) specifications/description; and (5) three appendices: performance of trunk allocation contention elimination (trace) method, LCN channel protocol and proposed LCN unified second level protocol.

G.Y.

**N79-26071#** Burroughs Corp., Paoli, Pa.

**NUMERICAL AERODYNAMIC SIMULATION FACILITY FEASIBILITY STUDY. EXECUTIVE SUMMARY**

Mar. 1979 24 p refs

(Contract NAS2-9897)

(NASA-CR-152284) Avail: NTIS HC A02/MF A01 CSCL 14B

There were three major issues examined in the feasibility study. First, the ability of the proposed system architecture to

support the anticipated workload was evaluated. Second, the throughput of the computational engine (the flow model processor) was studied using real application programs. Third, the availability, reliability, and maintainability of the system were modeled. The evaluations were based on the baseline systems. The results show that the implementation of the Numerical Aerodynamic Simulation Facility, in the form considered, would indeed be a feasible project with an acceptable level of risk. The technology required (both hardware and software) either already exists or, in the case of a few parts, is expected to be announced this year.

R.E.S.

N79-28072# Burroughs Corp., Paoli, Pa.  
**NUMERICAL AERODYNAMIC SIMULATION FACILITY FEASIBILITY STUDY Final Report**  
Mar. 1979 615 p  
(Contract NAS2-9897)  
(NASA-CR-152285) Avail: NTIS HC A99/MF A01 CSCL 14B

There were three major issues examined in the feasibility study. First, the ability of the proposed system architecture to support the anticipated workload was evaluated. Second, the throughput of the computational engine (the flow model processor) was studied using real application programs. Third, the availability, reliability, and maintainability of the system were modeled. The evaluations were based on the baseline systems. The results show that the implementation of the Numerical Aerodynamic Simulation Facility, in the form considered, would indeed be a feasible project with an acceptable level of risk. The technology required (both hardware and software) either already exists or, in the case of a few parts, is expected to be announced this year. Facets of the work described include the hardware configuration, software, user language, and fault tolerance R.E.S.

S N79-27044# Cornell Univ., Ithaca, N.Y. Dept. of Astronomy.  
**AIRBORNE INFRARED AND SUBMILLIMETER ASTRO-NOMICAL POLARIZATION MEASUREMENTS AT DIFFERENT WAVELENGTHS Final Technical Report, 1 Oct. 1977 - 31 Dec. 1978**  
Martin Harwit Jul 1979 7 p refs  
(Grant NSG-2262)  
(NASA-CR-158751) Avail: NTIS HC A02/MF A01 CSCL 03A

Because observations of the Kleinmann-Low region of the Orion Nebula reveal significant polarization in the wavelength range from 1 to 13 micron m. polarization at wavelengths greater than 15 micron were investigated. Far infrared polarization measurements were made of a number of sources using an instrument mounted at the bent cassegrain focus of the Kuiper Airborne Observatory's 90 cm telescope. About two hours of data were obtained on the Orion Nebula on each of two flights, and more careful calibration on Jupiter (assumed to be unpolarized) were obtained on both nights. The data on Orion and Jupiter for three filters are presented. Possible explanations are suggested for reconciling the high polarization observed by others in 1974 with the lower values obtained in this study. A.R.H.

N79-27944# Rochester Univ., N.Y. Dept. of Chemistry.  
**SEMICLASSICAL THEORY OF ELECTRONICALLY NON-ADIABATIC TRANSITIONS IN MOLECULAR COLLISION PROCESSES**  
Kai S. Lam and Thomas F. George 1979 83 p refs Presented at Proc. of the NATO Advanced Study Inst. on Semiclassical Methods in Scattering and Spectroscopy, 1979  
(Grant NSG-2198; Contract F49620-78-C-0005; Grant NSF CHE-77-27826)  
(NASA-CR-158776) Avail: NTIS HC A05/MF A01 CSCL 07D

An introductory account of the semiclassical theory of the S-matrix for molecular collision processes is presented, with special emphasis on electronically nonadiabatic transitions. This theory

is based on the incorporation of classical mechanics with quantum superposition, and in practice makes use of the analytic continuation of classical mechanics into the complex space of time domain. The relevant concepts of molecular scattering theory and related dynamical models are described and the formalism is developed and illustrated with simple examples - collinear collision of the A+BC type. The theory is then extended to include the effects of laser-induced nonadiabatic transitions. Two bound continuum processes collisional ionization and collision-induced emission also amenable to the same general semiclassical treatment are discussed.

A.R.H.

N79-28470# Grumman Aerospace Corp., Bethpage, N.Y.  
**CRYOGENIC THERMAL DIODE HEAT PIPES Final Report**  
J. Alario Feb 1979 59 p refs  
(Contract NAS2-7492)  
(NASA-CR-152268) Avail: NTIS HC A04/MF A01 CSCL 20D

The development of spiral artery cryogenic thermal diode heat pipes was continued. Ethane was the working fluid and stainless steel the heat pipe material in all cases. The major tasks included: (1) building a liquid blockage (blocking orifice) thermal diode suitable for the HEPP space flight experiment, (2) building a liquid trap thermal diode engineering model, (3) retesting the original liquid blockage engineering model, and (4) investigating the startup dynamics of artery cryogenic thermal diodes. An experimental investigation was also conducted into the wetting characteristics of ethane/stainless steel systems using a specially constructed chamber that permitted in situ observations.

G Y

N79-28643# Humboldt State Univ., Arcata, Calif. Center for Community Development.  
**DEVELOPING AND DEMONSTRATING AN INSTITUTIONAL MECHANISM FOR TRANSFERRING REMOTE SENSING TECHNOLOGY TO 14 WESTERN STATES USING NORTHERN CALIFORNIA AS THE TEST SITE Final Report, 1 Jun. 1977 - 31 Dec. 1978**  
Donna Hankins, Principal Investigator 31 Dec. 1978 622 p refs Original contains imagery. Original photography may be purchased from the EROS Data Center, Sioux Falls, S.D. 57198 ERTS  
(Grant NSG-2244)  
(E79-10229, NASA-CR-158758, Rept-3) Avail: NTIS HC A99/MF A01 CSCL 05B

There are no author-identified significant results in this report.

N79-28710# United Technologies Research Center, East Hartford, Conn.  
**SOLAR SUSTAINED PLASMA/ABSORBER CONCEPTUAL DESIGN Final Report, 1 Aug. 1978 - 28 Feb. 1979**  
Richard J. Rodgers, Nicholas L. Krascella, and John S. Kendall Feb 1979 61 p refs  
(Contract NAS2-10010)  
(NASA-CR-152304, R79-914392) Avail: NTIS HC A04/MF A01 CSCL 10A

A space power system concept was evaluated which uses concentrated solar energy to heat a working fluid to temperatures as high as 4000 K. The high temperature working fluid could be used for efficient electric power production in advanced thermal or magnetohydrodynamic conversion cycles. Energy absorber configurations utilizing particles or cesium vapor absorber material were investigated. Results of detailed radiant heat transfer calculations indicated approximately 86 percent of the incident solar energy could be absorbed within a 12-cm-dia flowing stream of gas borne carbon particles. Calculated total energy absorption in the cesium vapor seeded absorber configuration ranged from 34 percent to 64 percent of the incident solar energy. Solar flux concentration ratios of between approximately 3000 and 10,000 will be required to sustain absorber temperatures in the range from 3000 K to 4000 K.

F O S

N79-29142# Flow Research, Inc., Kent, Wash.  
**THE DIRECT NUMERICAL SIMULATIONS OF THE TURBULENT WAKES OF AXISYMMETRIC BODIES** Interim Report  
James J. Riley and Ralph W. Metcalfe Mar. 1978 84 p refs  
(Contract NAS2-9855)  
(NASA-CR-152282; RR-135) Avail: NTIS HC A05/MF A01 CSCL 01A

Results of direct numerical simulations of turbulence are compared with both laboratory data and self-similarity theory for the case of the turbulent wakes of towed, axisymmetric bodies. In general, the agreement of the simulation results with both the laboratory data and the self-similarity theory is good, although the comparisons are hampered by inadequate procedures for initializing the numerical simulations.

Author

N79-29333# McDonnell-Douglas Astronautics Co., St. Louis, Mo.  
**DEVELOPMENT, FABRICATION AND TEST OF A HIGH PURITY SILICA HEAT SHIELD** Final Report  
E. L. Ruser, D. N. Brennan, and M. S. Biggs Apr. 1978 120 p refs  
(Contract NAS2-8895)  
(NASA-CR-152117) Avail: NTIS HC A06/MF A01 CSCL 07D

A highly reflective hyperpure (< 25 ppm ion impurities) slip cast fused silica heat shield material developed for planetary entry probes was successfully scaled up. Process development activities for slip casting large parts included green strength improvements, casting slip preparation, aggregate casting, strength, reflectance, and subscale fabrication. Successful fabrication of a one-half scale Saturn probe (shape and size) heat shield was accomplished while maintaining the silica high purity and reflectance through the scale-up process. However, stress analysis of this original aggregate slip cast material indicated a small margin of safety (MS. = +4%) using a factor of safety of 1.25. An alternate hyperpure material formulation to increase the strength and toughness for a greater safety margin was evaluated. The alternate material incorporates short hyperpure silica fibers into the casting slip. The best formulation evaluated has a 50% by weight fiber addition resulting in an 80% increase in flexural strength and a 170% increase in toughness over the original aggregate slip cast materials with comparable reflectance.

A.W.H.

N79-31364# Boeing Commercial Airplane Co., Seattle, Wash.  
**DEVELOPMENT OF AIRCRAFT LAVATORY COMPARTMENTS WITH IMPROVED FIRE RESISTANCE CHARACTERISTICS. PHASE 2: SANDWICH PANEL RESIN SYSTEM DEVELOPMENT** Final Report  
R.A. Anderson, D.B. Arnold, and G.A. Johnson 1979 284 p refs  
(Contract NAS2-8700)  
(NASA-CR-152120; D8-46839) Avail: NTIS HC A13/MF A01 CSCL 11D

A NASA-funded program is described which aims to develop a resin system for use in the construction of lavatory wall panels, sidewall panels, and ceiling panels possessing flammability, smoke and gas emission, and toxicity (FS&T) characteristics superior to the existing epoxy resin. Candidate resins studied were phenolic, polyimide, and bismaleimide. Based on the results of a series of FS&T as well as mechanical and aesthetic property tests, a phenolic resin was chosen as the superior material. Material and process specifications covering the phenolic resin based materials were prepared and a method of rating sandwich panel performance was developed.

A.R.H.

N79-33121# Stanford Univ., Calif. Guidance and Control Lab.  
**CONTROL SYSTEM DESIGNS FOR THE SHUTTLE INFRARED TELESCOPE FACILITY**  
J. David Powell, Eric K. Parsons, and Kenneth R. Lorell Oct

1979 59 p refs  
(Grant NSG-2246)  
(NASA-CR-162321) Avail: NTIS HC A04/MF A01 CSCL 03A

The stringent pointing and stability requirements of the Shuttle Infrared and Telescope Facility (SIRTF) are stressed as well as the demands that infrared astronomy and the SIRTF in particular place on the design of the pointing system.

M.M.M.

## JOURNAL ARTICLES, BOOKS AND CHAPTERS OF BOOKS

A79-10162# Enhanced solar energy options using earth-orbiting mirrors. W. P. Gilbreath, K. W. Billman (NASA, Ames Research Center, Moffett Field, Calif.), and S. W. Bowen (Beam Engineering, Inc., Sunnyvale, Calif.). In: Intersociety Energy Conversion Engineering Conference, 13th, San Diego, Calif., August 20-25, 1978, Proceedings, Volume 2. (A79-10001 01-44) Warrendale, Pa.: Society of Automotive Engineers, Inc., 1978, p. 1528-1534. 11 refs.

A system of orbiting space reflectors is described, analyzed, and shown to economically provide nearly continuous insulation to preselected ground sites, producing benefits hitherto lacking in conventional solar farms and leading to large reductions in energy costs for such installations. Free-flying planar mirrors of about 1 sq km are shown to be optimum and can be made at under 10 g/sq m of surface, thus minimizing material needs and space transportation costs. Models are developed for both the design of such mirrors and for the analysis of expected ground insulation as a function of orbital parameters, time, and site location. Various applications (agricultural, solar-electric production, weather enhancement, etc.) are described.

(Author)

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A79-10589# Experimental investigation of contamination prevention techniques for a cryogenically cooled telescope in earth-orbit. M. A. Hetrick (Martin Marietta Aerospace, Denver, Colo.) and C. C. Pappas (NASA, Ames Research Center, Moffett Field, Calif.). In: Space Simulation Conference, 10th, Bethesda, Md., October 16-18, 1978, Technical Papers. (A79-10576 01-14) New York: American Institute of Aeronautics and Astronautics, Inc., 1978, p. 87-96. 12 refs. Contract No. NAS2-9816. (AIAA 78-1619)

A one-tenth scale model of the Shuttle Infrared Telescope Facility (SIRTF) was constructed to experimentally investigate the feasibility of a helium purge system to reduce contamination on cryogenic surfaces. The on-orbit ambient contaminant environment was simulated with ion beams of N<sub>2</sub>(+), O(+), and H<sub>2</sub>O(+). Helium was injected into the model telescope at the simulated plane of the primary optics using two techniques: a) porous plug, b) nozzle. Helium flow rates and telescope pressures were varied to determine the purge effectiveness against potential contaminants. Based on the subscale results, a 90% reduction in O, N<sub>2</sub>, and H<sub>2</sub>O at the primary optics of the SIRTF can be obtained using 20 K helium with a pressure of .00001 torr and a flow rate of less than 0.1 g/s. (Author)

A79-10624# Steady-state vortex-line density in turbulent He II counterflow. R. M. Ostermeier, M. W. Cromar, R. J. Donnelly (Oregon, University, Eugene, Ore.), and P. Kittel (NASA, Ames Research Center, Moffett Field, Calif.; Oregon, University, Eugene, Ore.). *Physical Review Letters*, vol. 41, Oct 16, 1978, p. 1123-1126. 12 refs. NSF Grant No. DMR-76-21814, Grant No. AF AFOSR 76-2880C.

We have measured the steady state vortex-line density in turbulent counterflow using a second sound burst technique as a local probe. Contrary to the Vinen theory and previous assumptions, we find substantial line density inhomogeneity and strong departures from the predicted heat-current dependence. Anomalous behavior of the line density at higher heat currents provides evidence for a new secondary flow state.

(Author)

**A79-11212 \*** The Pioneer Venus spacecraft program. S. D. Dorfman and C. M. Meredith (Hughes Aircraft Co., Los Angeles, Calif.). *International Astronautical Federation, International Astronautical Congress, 29th, Dubrovnik, Yugoslavia, Oct. 1-8, 1978, Paper 78-22, 21 p.* Contract No. NAS2-8300.

The Pioneer Venus program consists of two spacecraft: an orbiter and a multiprobe. Both will arrive at Venus in early December 1978. The orbiter will collect data on the upper atmosphere and fields and particles and will sense the clouds and surface remotely from a 75 deg inclined orbit. The multiprobe consists of a bus, three small probes, and a large probe. All five objects will enter the Venus atmosphere and will transmit data on its characteristics directly to earth while descending to the surface. The development of these spacecraft required the solution of many difficult and unique technical problems. (Author)

**A79-11388 #** An analysis of aircraft requirements to meet United States Department of Agriculture remote sensing goals. R. D. Arno (NASA, Ames Research Center, Applications Aircraft and Future Programs Office, Moffett Field, Calif.). In: Conference on the Economics of Remote Sensing Information Systems, 1st, San Jose, Calif., January 19-21, 1977, Proceedings. (A79-11376 01-43) San Jose, Calif., San Jose State University, 1977, p. 261-282.

The survey needs of the U.S. Department of Agriculture are immense, ranging from individual crop coverage at specific intervals to general land use classification. The aggregate of all desirable resolutions and sensor types applicable to airborne platforms yields an annual survey coverage rate equivalent to about 6 times the U.S. land area. An intermediate annual survey level equal to the U.S. area can meet all currently perceived crop survey needs and provide sample imagery over many other resource areas. This decreased survey level can be accomplished with one or two high altitude aircraft or medium altitude aircraft. Survey costs range from about 25 cents to several dollars per square nautical mile depending primarily on resolution requirements and the aircraft used. (Author)

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**A79-11503 \*** Compression of Jupiter's magnetosphere by the solar wind. E. J. Smith (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), R. W. Fillius (California, University, La Jolla, Calif.), and J. H. Wolfe (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Geophysical Research*, vol. 83, Oct. 1, 1978, p. 4733-4742, 25 refs. Contracts No. NAS7-100; No. NAS2-6552.

Simultaneous sets of interplanetary and planetary data obtained by Pioneer 10 and Pioneer 11 are compared with a view toward identifying major changes in the solar wind and their possible influence on the Jovian magnetosphere. The results are discussed relative to variations in magnetopause location, pressure balance at the magnetopause, acceleration of energetic trapped radiation, plasma density from the response time of the Jovian magnetosphere, and time constants of magnetospheric circuit models. A major finding is that three out of four cases in which the Pioneers reentered the magnetosheath are the result of time variations associated with changing interplanetary conditions. The compressibility of the Jovian magnetosphere is enhanced because the field inside the magnetopause is not the planetary field but is primarily caused by currents inside the magnetosphere, presumably the equatorial current sheet. S.D.

**A79-11512 \*** A time dependent model of the Jovian current sheet. M. G. Kivelson, P. J. Coleman, Jr., L. Froidevaux, and R. L. Rosenberg (California, University, Los Angeles, Calif.). *Journal of Geophysical Research*, vol. 83, Oct. 1, 1978, p. 4823-4829, 27 refs. Contract No. NAS2-7251; Grants No. NSG-7276; No. NSG-7295.

Analysis of vector helium magnetometer measurements during the Pioneer 10 outbound pass through the Jovian magnetosphere reveals that the average location of the near-equatorial current sheet is a surface whose shape is determined by the velocity at which the magnetic perturbations produced by a rotating tilted dipole propagate to large radial distances. A model is presented which is a surface

encircling the planet and rotating rigidly with it. Based on a linear fit to the times of the current sheet crossings, a formula is derived for the surface representing the average position of the near-equatorial current sheet in the Jovian magnetosphere. S.D.

**A79-11614 \*** The expected frequency of doublet craters /A reply/. V. R. Oberbeck (NASA, Ames Research Center, Moffett Field, Calif.). *Icarus*, vol. 35, Sept. 1978, p. 450, 451; Reply, p. 452, 453, 5 refs.

**A79-11633 \*** Effect of the reaction HO<sub>2</sub> + O<sub>3</sub> yields OH + 2O<sub>2</sub> on stratospheric ozone. R. C. Whitten, W. J. Borucki (NASA, Ames Research Center, Moffett Field, Calif.), L. A. Capone (San Jose State University, San Jose, Calif.), and R. P. Turco (R & P Associates, Marina del Rey, Calif.). *Nature*, vol. 275, Oct. 12, 1978, p. 523, 524, 14 refs.

It is noted that recent measurements of large values of the rate coefficient for the reaction NO + HO<sub>2</sub> yields NO<sub>2</sub> + OH lead to model predictions of excessive amounts of stratospheric ozone. This letter shows that a recent measurement of the rate coefficient (k<sub>2</sub>) for the reaction HO<sub>2</sub> + O<sub>3</sub> yields OH + 2O<sub>2</sub> largely resolves these problems of excessive stratospheric ozone in models. A two-dimensional model of stratospheric trace constituents is used to calculate the concentrations of 35 constituents; the results are compared with experimental measurements of ozone column densities. It is found that the model predictions of excess ozone abundances diminish significantly when the measured value of k<sub>2</sub> is employed. F.G.M.

**A79-12083 \*** Pioneer-Venus large probe infrared radiometer /LIR/ optical system. F. G. Brown, J. Gilliland, R. Hassig (Ball Brothers Research Corp., Boulder, Colo.), and R. W. Boese (NASA, Ames Research Center, Moffett Field, Calif.). In: Modern utilization of infrared technology III: Civilian and military; Proceedings of the Third Seminar, San Diego, Calif., August 25, 26, 1977. (A79-12067 02-35) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1977, p. 132-138. Contract No. NAS2-8807.

The LIR (large probe infrared radiometer) instrument has been developed for the NASA Ames Research Center for use in the 1978 Venus Atmospheric Probe Mission. The mission objectives are to determine the nature and composition of the clouds, the composition and structure of the atmosphere, and the atmospheric circulation pattern of the planet Venus. The LIR is a six-channel (3-50 micron) internally calibrated radiometer which measures the radiance difference at plus or minus 45 deg to the horizontal as viewed through a single diamond window in the spacecraft. The LIR optical system consists of a unique arrangement of hollow light pipes which optically couple a six element detector/filter array to the spacecraft window while mechanically and thermally isolating the array from the window's harsh thermal environment. A single rotating section with a 45 deg bend and containing a collimator alternately views up and down through director/extender pipes located adjacent to the diamond window. Light is transferred from the rotating section to a fixed section containing a diamond diffuser to scramble the light. This minimizes asymmetries and improves channel field of view overlap. (Author)

**A79-13047 \*** Isotopic anomalies in solar system material - What can they tell us. D. C. Black (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.). In: The origin of the solar system. (A79-13026 03-91) Chichester, Sussex, England and New York, Wiley-Interscience, 1978, p. 583-596, 25 refs.

Three relatively recently discovered anomalies are considered. The goal of isotopic research is to understand what phenomena are responsible for the observed isotopic anomalies, and thereby to determine the initial solar system isotopic composition. Until recently there has been no measured isotopic ratios which could not

be understood in the context of reasonable physical or chemical processes acting to alter a uniform initial solar isotopic composition. This situation changed in 1969 with the discovery by Black and Pepin of an unusual neon isotopic composition in certain carbonaceous meteorites. This unusual composition was later designated as Neon E. An unusual or anomalous oxygen isotopic composition was discovered by Clayton et al. (1973). A magnesium isotopic anomaly was discovered by Gray and Compton (1974), and Lee and Papanastassiou (1974). The three isotopic anomalies are discussed, emphasizing particularly the experimental evidence, possible causes for the observed isotopic composition and finally, possible implications of these anomalies with regard to models of solar system formation and evolution.

G.R.

A79-13057 \* Theoretical study of the photodissociation of HOCl. R. L. Jaffe and S. R. Langhoff (NASA, Ames Research Center, Computational Chemistry Group, Moffett Field, Calif.). *Journal of Chemical Physics*, vol. 68, Feb. 15, 1978, p. 1638-1648. 41 refs.

A study of the UV photodissociation of hypochlorous acid is conducted on the basis of ab initio SCF-Cl calculations. These calculations show that HOCl has only a single peak in the UV photoabsorption spectrum at 220 nm. This result implies that HOCl would have a long lifetime for photodissociation if it were to be formed in the stratosphere. The photodissociation products of HOCl have been identified as Cl+OH, based on an examination of the topographies of the excited electronic state potential energy surfaces. The results of this study indicate that HOCl could be a significant reservoir for stratospheric chlorine.

G.R.

A79-13111 \* # Martian atmosphere modeling between 0.4 and 3.5 microns - Comparison of theory and experiment. W. G. Egan, W. L. Fischbein, T. Hilgeman, and L. L. Smith (Grumman Aerospace Corp., Bethpage, N.Y.). In: Symposium on Planetary Atmospheres, 19th, Ottawa, Canada, August 16-19, 1977, Proceedings. (A79-13101 03-91) Ottawa, Royal Society of Canada, 1978, p. 57-60. 10 refs. Contract No. NAS2-8664.

A model of the lower atmosphere of Mars has been constructed that combines aerosol absorption and scattering with a line-by-line analysis of CO<sub>2</sub> and H<sub>2</sub>O in a multilayer radiative transfer program. Aerosol composition previously inferred from the NASA Lear Jet Observatory data was used to measure the optical complex indices of refraction of appropriate Martian analogs from 0.4 to 2.5 microns. The aerosol vertical particle density scale was deduced using the Viking camera observations of the soil and sky intensities between 0.4 and 1.0 microns in comparison with those modeled using a multilayer Mie scattering program. A comparison of observed Mars atmospheric absorptions was made with those obtained using Lorentz, Voigt, and Doppler line profiles in a multilayer model of the CO<sub>2</sub> and H<sub>2</sub>O. The Voigt line profile of CO<sub>2</sub> absorption at approximately 4976 kaysers was then combined in a multilayer aerosol model of the Martian atmosphere. An evaluation of the effect on the line shape was made using several aerosol loadings. (Author)

A79-13126 \* # Thermal structure of Mars' atmosphere from Viking entry measurements. A. Seiff (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.). In: Symposium on Planetary Atmospheres, 19th, Ottawa, Canada, August 16-19, 1977, Proceedings. (A79-13101 03-91) Ottawa, Royal Society of Canada, 1978, p. 135-140. 14 refs.

An experimental study using accelerometers as well as pressure and temperature sensors was carried out for accurate determination of the thermal structure of the atmosphere of Mars from nominally 100-km altitude to the planet surface during atmosphere entry of the two Viking landers. A comparison was made with the neutral thermal structure above 130 km and with the ion temperatures. Both entries exhibited strong temperature fluctuations about the mean, which was attributed to thermal tides. The mean temperature of the atmosphere above the boundary layer was shown to be governed by

radiative equilibrium, while the radiative boundary layer was observed to be 4 km deep. Ion temperatures indicated a structure correlated with that of the neutral atmosphere at altitudes up to 160 km. Thickness of the convective boundary layer was 6.5 km in late summer afternoon.

S.D.

A79-13176 \* A dispersion relationship governing incompressible wall turbulence. S. Tsuge (Nielsen Engineering and Research, Inc., Mountain View, Calif.). In: Structure and mechanisms of turbulence II; Proceedings of the Symposium on Turbulence, Berlin, West Germany, August 1-5, 1977. (A79-13133 03-34) Berlin, Springer-Verlag, 1978, p. 325-336. 10 refs. Contract No. NAS2-9535.

The method of separation of variables is shown to make turbulent correlation equations of Karman-Howarth type tractable for shear turbulence as well under the condition of neglected triple correlation. The separated dependent variable obeys an Orr-Sommerfeld equation. A new analytical method is developed using a scaling law different from the classical one due to Heisenberg and Lin and more appropriate for wall turbulent profiles. A dispersion relationship between the wave number and the separation constant which has the dimension of a frequency is derived in support of experimental observations of wave or coherent structure of wall turbulence. (Author)

A79-13319 \* Adaptive coding of MSS imagery. A. Habibi, A. S. Samulon, G. L. Fultz (TRW Defense and Space Systems Group, Redondo Beach, Calif.), and D. Lumb (NASA, Ames Research Center, Moffett Field, Calif.). In: NTC '77; National Telecommunications Conference, Los Angeles, Calif., December 5-7, 1977, Conference Record, Volume 1. (A79-13301 03-32) New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 10:2-1 to 10:2-8. 7 refs. Contract No. NAS2-8394.

A number of adaptive data compression techniques are considered for reducing the bandwidth of multispectral data. They include adaptive transform coding, adaptive DPCM, adaptive cluster coding, and a hybrid method. The techniques are simulated and their performance in compressing the bandwidth of Landsat multispectral images is evaluated and compared using signal-to-noise ratio and classification consistency as fidelity criteria. (Author)

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A79-13429 \* The albedo of Titan. M. Podolak (Tel Aviv University, Tel Aviv, Israel) and L. Giver (NASA, Ames Research Center, Moffett Field, Calif.). In: Space research XVIII; Proceedings of the Open Meetings of the Working Groups on Physical Sciences, Tel Aviv, Israel, June 7-18, 1977. (A79-13382 03-88) Oxford, Pergamon Press, Ltd., 1978, p. 463, 464. 6 refs.

It is shown that a two-layer model of Titan's atmosphere is required in order to match laboratory data on methane absorption to ground-based IR observations of Titan. An excellent fit to the observations is obtained with a model where the dust in Titan's atmosphere is confined to a region containing 50 m-am of methane and located above an atmosphere with 1.95 km-am of methane, with the amount of dust being the value required for an extinction optical depth of 5 at 0.5 micron. The surface reflectivity required by this model is about 40% to 50%, which is typical for both dirty snow and clouds. The possibility is discussed of distinguishing between two scenarios for the observed surface of Titan (a true surface or just cloud tops) on the basis of limb-darkening curves obtained at many wavelengths with an orbiting telescope or a flyby mission. F.G.M.

A79-13719 \* Electron heating of inflowing interstellar gas. F.-M. Wu and D. L. Judge (Southern California, University, Los Angeles, Calif.). *Astrophysical Journal, Part 1*, vol. 225, Nov. 1, 1978, p. 1045-1049. 25 refs. Contract No. NAS2-6558.

The heating of inflowing interstellar gas by solar electrons is calculated. In the present work it is assumed that the thermal energy

of the electrons is constant with distance from the Sun and that the inflowing gas follows Keplerian trajectories, and the contours of constant temperature so obtained are given. At a heliocentric distance of 1 AU the estimated temperature is 500 K upwind and 2000 K downwind for hydrogen atoms, and is 240 K downwind and 100 K upwind for helium. (Author)

**A79-13722 \*** Temperature and ionization balance dependence of O VII line ratios. L. W. Acton and W. A. Brown (Lockheed Research Laboratories, Palo Alto, Calif.). *Astrophysical Journal, Part 1*, vol. 225, Nov. 1, 1978, p. 1065-1068. 13 refs. Research supported by the Lockheed Independent Research Program; Contract No. NAS2-9181; Grant No. NGR-12-001-075.

The forbidden-plus-intersystem to resonance line ratio ( $G$ ) for the heliumlike ion O VII is calculated, taking into account cascades, blended satellite lines, and radiative plus dielectric recombination. It is noted that  $G$  is of particular use for investigating radiative-transfer effects and nonequilibrium ionization in the solar corona and that the calculations are applicable to a low-density optically thin Maxwellian plasma. The temperature dependence of  $G$  is considered for the case of a steady-state equilibrium plasma, and the effect of departures from ionization equilibrium on  $G$  is examined. It is found that  $G$  is quite insensitive to temperature over the range from 600,000 to 6 million K for a steady-state plasma, but that recombinations may be suppressed or dominant, depending on the relative abundance of O VIII, for a plasma in which the state of ionization is not in equilibrium with the electron temperature. This latter effect is shown to be capable of causing large variations in  $G$  that are dependent on electron temperature. F.G.M.

**A79-13723 \*** Radiative transfer of X-rays in the solar corona. L. W. Acton (Lockheed Research Laboratories, Palo Alto, Calif.). *Astrophysical Journal, Part 1*, vol. 225, Nov. 1, 1978, p. 1069-1075. 27 refs. Research supported by the Lockheed Independent Research Program; Grant No. NGR-12-001-075; Contract No. NAS2-9181.

The problem of resonance scattering of X-ray emission lines in the solar corona is investigated. For the resonance lines of some helium-like ions, significant optical depths are reached over distances small compared with the size of typical coronal features. A general integral equation for the transfer of resonance-line radiation under solar coronal conditions is derived. This expression is in a form useful for modeling the complex three-dimensional temperature and density structure of coronal active regions. The transfer equation is then cast in a form illustrating the terms which give rise to the attenuation or enhancement of the resonance-line intensity. The source function for helium-like oxygen (O VII) under coronal conditions is computed and discussed in terms of the relative importance of scattering. (Author)

**A79-13728 \*** Gas flow in the barred spiral galaxy NGC 5383. J. M. Huntley (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). *Astrophysical Journal, Part 2 - Letters to the Editor*, vol. 225, Nov. 1, 1978, p. L101-L105. 20 refs.

Line-of-sight gas velocities calculated from a numerical hydrodynamical model of a barred spiral galaxy are compared with the observations and models made by Peterson, Rubin, Ford, and Thonnard of the gas flow in NGC 5383. The hydrodynamical model provides a somewhat better fit to the observations of NGC 5383 than does their symmetric, warped-disk model. It is argued that the basic model appropriate to understanding the gas motions in barred spiral galaxies is not circular rotation but rather a characteristic elliptical pattern of flow. (Author)

**A79-13751 \*** Axisymmetric disturbances in a disk galaxy. R. H. Miller (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.; Chicago, University, Chicago,

III.). *Astrophysical Journal, Part 1*, vol. 226, Nov. 15, 1978, p. 81-86. 10 refs. Grant No. NCA2-OR108-801.

The Lin-Shu dispersion relation, with corrections to match experimental conditions and in combination with a quantization rule, permits growth rates to be calculated for axisymmetric disturbances in an axisymmetric disk of stars. Growth rates calculated this way are in reasonable quantitative agreement with recently published results from a series of numerical experiments. The agreement confirms the physical basis of the theory and demonstrates that the theory remains valid even when strained somewhat in the application to galactic models. (Author)

**A79-13830 \*** On-board data processing for the IRAS telescope system. H. Lum (NASA, Ames Research Center, Moffett Field, Calif.), D. Wong (Informatics, Inc., Palo Alto, Calif.), E. Long (Ball Brothers Research Corp., Boulder, Colo.), and P. Neal. *American Institute of Aeronautics and Astronautics and NASA, Conference on 'Smart' Sensors, Hampton, Va., Nov. 14-16, 1978, AIAA Paper 78-1711*. 7 p.

Onboard data processing has been developed for the Infrared Astronomical Satellite (IRAS) telescope system to effectively utilize the RF bandwidth and minimize the ground-data processing costs. Use of filtering techniques, data deglitching circuits, and data encoding algorithms are combined with a microprocessor-controlled telescope system to achieve a system dynamic range of 100,000 with a noise equivalent flux density of no less than 10 to the minus 19th W/sq cm. Extraneous data, e.g., noise due to radiation hits, will be removed prior to transmission, thereby optimizing ground-data processing for the highest sensitivity and reliability. Simulation results are presented which demonstrate the advantages gained through the use of onboard data processing and illustrate the possible merging of these techniques with an array for the future evolution of 'smart' sensors. (Author)

**A79-13831 \*** Integrated detector array preprocessing for infrared astronomical applications. C. R. McCreight and H. Lum (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics and NASA, Conference on 'Smart' Sensors, Hampton, Va., Nov. 14-16, 1978, AIAA Paper 78-1712*. 8 p. 17 refs.

On-board preprocessing of astronomical data from integrated infrared detector arrays and discrete detectors will allow increases in sensitivity and reductions in costs for observations from cryogenic space telescopes. A variety of preprocessing functions for this application, which could be implemented either through analog on-chip devices or through external microprocessors, is identified. Software simulations and laboratory evaluations are underway to determine the effectiveness of these preprocessing schemes. (Author)

**A79-14065 \*** Performance comparison of earth and space storable bipropellant systems in interplanetary missions. H. F. Meissinger (TRW Defense and Space Systems Group, Redondo Beach, Calif.). *Deutsche Gesellschaft für Luft- und Raumfahrt and Hermann-Oberth-Gesellschaft, Deutscher Luft- und Raumfahrtkongress, Darmstadt, West Germany, Sept. 19-23, 1978, DGLR Paper 78-104*. 31 p. 12 refs. Contract No. NAS2-8370.

The paper evaluates and compares the performance of earth-storable and space-storable liquid bipropellant propulsion systems in high-energy planetary mission applications, including specifically Saturn and Mercury orbiters, as well as asteroid and comet rendezvous missions. The discussion covers a brief review of the status of space-storable propulsion technology, along with an illustrative propulsion module design for a three-axis stabilized outer planet and cometary mission spacecraft of the Mariner class. The results take revised Shuttle/Upper Stage performance projections into account. It is shown that in some of the missions the performance improvement achievable in the ballistic transfer mode with space-storable spacecraft propulsion can provide a possible alternative to the use of solar-electric propulsion. S.D.

**A79-14598 \*** Thermal rearrangements of unsaturated polymers. M. A. Golub (NASA, Ames Research Center, Moffett Field, Calif.). In: *U.S.-Japan Joint Seminar on Elastomers, Akron, Ohio, Oct. 17-21, 1977*. *Rubber Chemistry and Technology*, vol. 51, Sept.-Oct. 1978, p. 677-685. 27 refs.

Thermal anaerobic uncatalyzed cyclizations and cis-trans isomerizations observed in unsaturated hydrocarbon polymers are surveyed. Three main types of cyclizations are described. Type I is a radical reaction which is caused by chain rupture and gives rise to six-membered rings; this reaction occurs during pyrolysis of polymers with double bonds in a 1,5- or 1,6-diene configuration. Type II is a (2 + 2) thermal cycloaddition of double bonds in certain polymers with a 1,6-diene structure; bicycloheptane structures result. Type III is an intramolecular ene reaction. Many polymers containing a double bond linking CH units display thermal cis-trans isomerization. The common activation energy is approximately 130 kJ/mol, and the initial rate constants are lower, for homologous polymers, the greater the separation of the carbon-carbon double bonds. M.L.

**A79-14944 \*** The ammonia mixing ratio in Jupiter's stratosphere. D. Goorvitch (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.). *Icarus*, vol. 36, Oct. 1978, p. 127-132. 22 refs.

The paper describes the theory that underlies the model calculations which show that the far-infrared bands of ammonia are very sensitive to the ammonia distribution above the Jovian atmospheric inversion layer. Observation of the  $J = 5$  and  $J = 6$  ammonia bands at moderate resolution might permit choice between a cold trap model or the irreversible uv photodestruction model for the ammonia distribution. The lack of prominent emission cores in the NH<sub>3</sub> rotation-inversion lines only implies that the mixing ratio is low. The ammonia is uniformly mixed if the inversion temperature is low but, at a higher inversion temperature, emission cores will be observed unless the photodissociation is extremely efficient down to at least the inversion layer. M.L.

**A79-15106 \*** Stratospheric aerosols and climatic change. O. B. Toon and J. B. Pollack (NASA, Ames Research Center, Moffett Field, Calif.). In: *Joint Conference on Sensing of Environmental Pollutants*, 4th, New Orleans, La., November 6-11, 1977. *Proceedings*. (A79-15023 04-45) Washington, D.C., American Chemical Society, 1978, p. 681, 682. 7 refs.

Stratospheric sulfuric acid particles scatter and absorb sunlight and they scatter, absorb and emit terrestrial thermal radiation. These interactions play a role in the earth's radiation balance and therefore affect climate. The stratospheric aerosols are perturbed by volcanic injection of SO<sub>2</sub> and ash, by aircraft injection of SO<sub>2</sub>, by rocket exhaust of Al<sub>2</sub>O<sub>3</sub> and by tropospheric mixing of particles and pollutant SO<sub>2</sub> and COS. In order to assess the effects of these perturbations on climate, the effects of the aerosols on the radiation balance must be understood and in order to understand the radiation effects the properties of the aerosols must be known. The discussion covers the aerosols' effect on the radiation balance. It is shown that the aerosol size distribution controls whether the aerosols will tend to warm or cool the earth's surface. Calculations of aerosol properties, including size distribution, for various perturbation sources are carried out on the basis of an aerosol model. Calculations are also presented of the climatic impact of perturbed aerosols due to volcanic eruptions and Space Shuttle flights. (Author)

**A79-15107 \*** Properties of the stratospheric aerosol layer studied with a one-dimensional computer model. R. P. Turco (R & D Associates, Marina del Rey, Calif.), O. B. Toon (NASA, Ames Research Center, Moffett Field, Calif.), Cornell University, Ithaca, N.Y.), R. C. Whitten (NASA, Ames Research Center, Moffett Field, Calif.), P. Hamill (Universidad Católica, Caracas, Venezuela), and C. S. Kiang (National Center for Atmospheric Research, Boulder, Colo.). In: *Joint Conference on Sensing of Environmental Pollutants*, 4th, New Orleans, La., November 6-11, 1977. *Proceedings*. (A79-

15023 04-45) Washington, D.C., American Chemical Society, 1978, p. 683-688, 38 refs.

Aerosol particle effects are often neglected in theoretical studies of stratospheric phenomena. In reality, the particulate matter normally found above the tropopause may influence the terrestrial radiation balance, catalyze heterogeneous chemical interactions, and serve as a tracer of atmospheric motions. The paper proposes a one-dimensional model of the stratospheric aerosol layer, and it is used to compare aerosol theory with observational data. The model considers gaseous sulfur photochemistry and the physical aerosol processes of nucleation, coagulation, sedimentation, and diffusion. Calculations of the effects on the aerosol layer of stratospheric injections of aluminum oxide particles by Space Shuttle engines and of sulfur dioxide molecules by volcanic activity are performed. The relation between measured aerosol variability and changes in stratospheric air temperatures and vertical transport rates are discussed.

(Author)

**A79-15220 \*** Spectral studies of SiCl<sub>4</sub> + N<sub>2</sub>O + Ar and SiH<sub>4</sub> + Ar mixtures in a shock tube in 160-550 nm range. C. Park and T. Fujiwara (NASA, Ames Research Center, Moffett Field, Calif.). In: *Shock tube and shock wave research; Proceedings of the Eleventh International Symposium*, Seattle, Wash., July 11-14, 1977. (A79-15207 04-34) Seattle, Wash., University of Washington Press, 1978, p. 148-155. 16 refs.

Gases containing SiO, SiO<sub>2</sub>, SiH, and Si<sub>2</sub> were produced in the reflected-shock region of a shock tube by heating SiCl<sub>4</sub> + N<sub>2</sub>O + Ar and SiH<sub>4</sub> + Ar mixtures with shock waves. Spectral absorption characteristics were measured in the 160-550 nm wavelength range and in the 2800-3600 K temperature range and compared to calculated values. The sums of the squares of electronic transition moments at equilibrium separation were derived. It was found that absorption by SiO<sub>2</sub> and other known bands of SiO, SiH, and Si<sub>2</sub> were too weak to be measured. The cross section of absorption by a continuum, believed due to SiH, varied from  $2.5 \times 10$  to the -17th sq cm at 280 nm to  $1.6 \times 10$  to the -18th sq cm at 440 nm. S.C.S.

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**A79-15225 \*** Stratospheric-related research using the shock tube. D. M. Cooper, C. Park, and C. A. Boitnott (NASA, Ames Research Center, Moffett Field, Calif.). In: *Shock tube and shock wave research; Proceedings of the Eleventh International Symposium*, Seattle, Wash., July 11-14, 1977. (A79-15207 04-34) Seattle, Wash., University of Washington Press, 1978, p. 193-199. 20 refs.

The capabilities of shock tubes used in stratospheric-related research are considered, and the results of three independent shock tube research projects are reported. The studies are concerned with the evaluation of stratospheric ozone depletion. In the first experiment, photoabsorption cross sections of Freon 11 and 12 at stratospheric temperatures were measured using rarefaction waves. In the second experiment, reaction-rate coefficients were determined from measurements made behind reflected shock waves. In the third experiment, electronic-transition moments of the O<sub>2</sub> Schumann-Rungé system and the A<sub>2</sub>Pi-X<sub>2</sub>Pi system of ClO were deduced from intensity measurements made behind the incident shock. M.L.

**A79-15252 \*** A new look at performance capabilities of arc-driven shock tubes. R. E. Dannenberg (NASA, Ames Research Center, Moffett Field, Calif.). In: *Shock tube and shock wave research; Proceedings of the Eleventh International Symposium*, Seattle, Wash., July 11-14, 1977. (A79-15207 04-34) Seattle, Wash., University of Washington Press, 1978, p. 416-431. 25 refs.

High shock-tube velocities simulating Jovian entry have been achieved w.th arc-driver operation using a method of tailoring electrical circuit impedance to arc-plasma impedance. The concept of impedance matching also prescribes a requirement for minimum electrical capacitance. The technique of developing the strongest shock-generating capability for an arc-driver system with the least total energy is discussed. Several programs using the shock tube for developmental research in energy and industrial applications are outlined. (Author)

**A79-15980 \*** Reservoirs of atmospheric chlorine - Prospects for HOCl revisited. S. S. Prasad (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), R. L. Jaffe, R. C. Whitten (NASA, Ames Research Center, Moffett Field, Calif.), and R. P. Turco (R & D Associates, Marina del Rey, Calif.). *Planetary and Space Science*, vol. 26, Nov. 1978, p. 1017-1026. 28 refs. Contract No. NAS7-100.

Possible effects of HOCl aeration in the terrestrial stratosphere are reexamined. Chemical kinetics data for HOCl are analyzed which are required in aeronomical studies, and the possible role of HOCl as a reservoir of atmospheric chlorine is evaluated. Chemical production and loss of HOCl in the stratosphere is considered, along with photolysis of HOCl and prospects for HOCl as an inert chlorine reservoir. It is shown that a recent theoretical calculation of the HOCl photodissociation cross section suggests this species as a possible significant reservoir of atmospheric chlorine, but that the theoretical calculations are in sharp disagreement with some experimental measurements. Laboratory and atmospheric experiments to clarify the uncertainties of HOCl aeration are proposed. F.G.M.

**A79-15984 \*** Low background focal plane array testing in the far infrared. E. J. Iufer (NASA, Ames Research Center, Moffett Field, Calif.). In: Utilization of infrared detectors; Proceedings of the Seminar, Los Angeles, Calif., January 16-18, 1978. (A79-15978 04-35) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 52-56.

A new long-wavelength infrared test facility is being developed to conduct proof-of-performance tests of focal plane arrays for the Infrared Astronomical Satellite (IRAS) telescope. This facility is believed to be unique in that it will calibrate full-sized arrays designed for the 5-120-micron region of the IR spectrum under simulated spaceflight conditions and at background levels as low as 8 million photons/sq cm-sec. Most of the tests will be performed in a main test chamber which contains a liquid helium shroud, blackbody sources, an arrangement to simulate zodiacal background, and spot scanning optics. A noncontaminating high-vacuum pumping system will be used to evacuate the chamber prior to cool-down to prevent molecular deposition. All housekeeping and focal plane signal outputs are multiplexed, digitized, and transmitted on high-speed data lines to a PDP-11/70 computer. The computer provides real-time displays on a color CRT terminal and stores data for subsequent reduction and hard copy output. An overview of the conceptual design and performance specifications of the test facility are given. (Author)

**A79-15986 \*** Infrared Astronomical Satellite /IRAS/ and Shuttle Infrared Telescope Facility /SIRTF/ - Implications of scientific objectives on focal plane sensitivity requirements. C. R. McCleight, R. G. Walker, and F. C. Witteborn (NASA, Ames Research Center, Moffett Field, Calif.). In: Utilization of infrared detectors; Proceedings of the Seminar, Los Angeles, Calif., January 16-18, 1978. (A79-15978 04-35) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 66-74. 13 refs.

The full potential of infrared astronomy can be realized only through observations made with space-based telescopes cooled to cryogenic temperatures. The paper outlines the scientific mission, system description, and focal plane requirements for two cryogenic telescopes: the Infrared Astronomical Satellite (IRAS) and the Shuttle Infrared Telescope Facility (SIRTF). IRAS, a 60-cm superfluid-helium-cooled telescope system, will perform a one-year 8-120-micron IR sky survey; it will provide results of high reliability and sensitivity, produce the first complete survey data for the 30-120-micron region, and fill in missing portions (spectrally and spatially) of previous surveys short of 30 microns; its focal plane assembly is being designed to approach background-limited performance with an array of 62 discrete detectors. The SIRTF design will allow detailed follow-up studies in the 1-1000-micron range with a 116-160-cm observatory-class instrument. The Shuttle sortie capability introduces the unique SIRTF concept of an easily refurbishable or replaceable focal plane instrument complement in an orbiting cryogenic telescope.

**A79-15988 \*** Infrared detector performance in the Shuttle Infrared Telescope Facility /SIRTF/. S. G. McCarthy and G. W. Autio (Hughes Aircraft Co., Culver City, Calif.). In: Utilization of infrared detectors; Proceedings of the Seminar, Los Angeles, Calif., January 16-18, 1978. (A79-15978 04-35) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 81-88. 8 refs. Contract No. NAS2-8494.

The limitations imposed on infrared detectors for SIRTF are quite different from those imposed on ground-based, balloon-borne, or aircraft-borne systems. The paper examines the limitations and provides performance predictions corresponding to SIRTF conditions. Detector parameters typical of an infrared camera are used. The detector size is taken to be of the order of the diffraction-limited spot, frequency response is taken to correspond to a fraction of a second or less time constant, and spectral definition is provided by multilayer dielectric filters, inductive or capacitive grids, intrinsic absorption, or a combination of these. A nominal 10-micron bandwidth is assumed. The discussion covers atmospheric absorption and emission, zodiacal dust radiance, Shuttle contaminants, telescope self-emission, charged particle radiation, clear environment detector performance, and trapped radiation effects. It is concluded that the SIRTF design and operating conditions will allow current and near-term state-of-the-art detectors to reach their performance limits with SIRTF at a temperature of 10-12 K. S.D.

**A79-15990 \*** Ge:Ga and Ge:Be photoconductive detectors for far infrared astronomy from a space platform. P. R. Bratt, N. N. Lewis, and R. L. Nielsen (Santa Barbara Research Center, Goleta, Calif.). In: Utilization of infrared detectors; Proceedings of the Seminar, Los Angeles, Calif., January 16-18, 1978. (A79-15978 04-35) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 97-107. 12 refs. Contracts No. NAS2-9385; No. NAS2-9599.

The paper describes some of the development work on gallium-doped germanium (Ge:Ga) and beryllium-doped germanium (Ge:Be) photoconductive detectors for use in far-infrared astronomical observations from a space platform such as IRAS. The paper is concerned primarily with detector performance and is divided into two major parts. The first presents the operating principles of this type of detector, while the second presents measured performance data under low-background flux conditions. It is shown that high sensitivity can be obtained from Ge:Ga and Ge:Be detectors under low-background and low-temperature conditions of operation. These detectors are useful for astronomical observations in the far-infrared over the wavelength range 30-120 microns. Major conclusions of the research work done so far are mentioned, including that detectors cut from the same crystal show reasonably good reproducibility of operating characteristics. S.D.

**A79-16049 \*** Reynolds number influence on leeside flowfields. J. Szodruch (NASA, Ames Research Center, Moffett Field, Calif., Berlin, Technische Universität, Berlin, West Germany). *AIAA Journal*, vol. 16, Dec. 1978, p. 1306-1309. 8 refs.

Experimental results on the Reynolds number influence on the leeside flowfield of planar delta wings at supersonic speeds are presented. Wind tunnel experiments on two delta wing models with straight and sharp leading edges at freestream Mach number of 2.5 and 3.5 and angle of attack between 1 deg and 12.5 deg were carried out. The cross-sectional shape was triangular and the relative height was 0.25. The flow types investigated were to the left and right of the Stanbrook-Squire boundary. Under leading-edge separation conditions, the vortex position and intensity, and thus the suction pressure, vary with Re while the flow type remains nearly unchanged. In the region of separation with embedded shock, Re affects not only the shape of the separation bubble and pressure level near the leading edge but also the type of flow. At sufficiently high Re the flow type of separation with shock changes to one with shock-induced separation. P.T.H.

**A79-16605 \* # Orbiting mirrors for terrestrial energy supply.** K. W. Billman, W. P. Gilbreath (NASA, Ames Research Center, Moffett Field, Calif.), and S. W. Bowen. In: *Radiation energy conversion in space; Conference, 3rd, Moffett Field, Calif., January 26-28, 1978, Technical Papers. (A79-16601 04-44)* New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 61-80. 15 refs.

A system of orbiting reflectors termed 'SOLARES' is proposed as a means of reducing the diurnal variation and increasing the average intensity of sunlight for terrestrial solar power systems. The paper discusses orbital considerations for the placement of the reflectors, insolation profiles, ground conversion options, costs, and environmental and social effects. P.T.H.

**A79-16608 \* # A search for space energy alternatives.** W. P. Gilbreath and K. W. Billman (NASA, Ames Research Center, Moffett Field, Calif.). In: *Radiation energy conversion in space; Conference, 3rd, Moffett Field, Calif., January 26-28, 1978, Technical Papers. (A79-16601 04-44)* New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 107-125. 36 refs.

This paper takes a look at a number of schemes for converting radiant energy in space to useful energy for man. These schemes are possible alternatives to the currently most studied solar power satellite concept. Possible primary collection and conversion devices discussed include the space particle flux devices, solar windmills, photovoltaic devices, photochemical cells, photoemissive converters, heat engines, dielectric energy conversion, electrostatic generators, plasma solar collectors, and thermionic schemes. Transmission devices reviewed include lasers and masers. P.T.H.

**A79-16623 \* # Systems efficiency and specific mass estimates for direct and indirect solar-pumped closed-cycle high-energy lasers in space.** D. J. Monson (NASA, Ames Research Center, Moffett Field, Calif.). In: *Radiation energy conversion in space; Conference, 3rd, Moffett Field, Calif., January 26-28, 1978, Technical Papers. (A79-16601 04-44)* New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 333-345. 11 refs.

Based on expected advances in technology, the maximum system efficiency and minimum specific mass have been calculated for closed-cycle CO and CO<sub>2</sub> electric-discharge lasers (EDL's) and a direct solar-pumped laser in space. The efficiency calculations take into account losses from excitation gas heating, ducting frictional and turning losses, and the compressor efficiency. The mass calculations include the power source, radiator, compressor, fluids, ducting, laser channel, optics, and heat exchanger for all of the systems; and in addition the power conditioner for the EDL's and a focusing mirror for the solar-pumped laser. The results show the major component masses in each system, show which is the lightest system, and provide the necessary criteria for solar-pumped lasers to be lighter than the EDL's. Finally, the masses are compared with results from other studies for a closed-cycle CO<sub>2</sub> gasdynamic laser (GDL) and the proposed microwave satellite solar power station (SSPS). (Author)

**A79-16629 \* # The TELEC - A plasma type of direct energy converter.** E. J. Britt (Rasor Associates, Inc., Sunnyvale, Calif.). In: *Radiation energy conversion in space; Conference, 3rd, Moffett Field, Calif., January 26-28, 1978, Technical Papers. (A79-16601 04-44)* New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 421-436. 5 refs. Contract No. NAS2-9109.

The Thermo-Electronic Laser Energy Converter (TELEC) is a high-power density plasma device designed to convert a 10.6-micron CO<sub>2</sub> laser beam into electric power. Electromagnetic radiation is absorbed in plasma electrons, creating a high-electron temperature. Energetic electrons diffuse from the plasma and strike two electrodes having different areas. The larger electrode collects more electrons and there is a net transport of current. An electromagnetic field is generated in the external circuit. A computer program has been designed to analyze TELEC performance allowing parametric varia-

tion for optimization. Values are presented for TELEC performance as a function of cesium pressure and for current density and efficiency as a function of output voltage. Efficiency is shown to increase with pressure, reaching a maximum over 45%. S.C.S.

**A79-16633 \* # Study, optimization, and design of a laser heat engine.** R. T. Taussig, P. E. Cassady, and J. F. Zumdieck (Mathematical Sciences Northwest, Inc., Bellevue, Wash.). In: *Radiation energy conversion in space; Conference, 3rd, Moffett Field, Calif., January 26-28, 1978, Technical Papers. (A79-16601 04-44)* New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 498-523. 20 refs. Contract No. NAS2-9668.

Laser heat engine concepts, proposed for satellite applications, are analyzed to determine which engine concept best meets the requirements of high efficiency (50 percent or better), continuous operation in space using near-term technology. The analysis of laser heat engines includes the thermodynamic cycles, engine design, laser power sources, collector/concentrator optics, receiving windows, absorbers, working fluids, electricity generation, and heat rejection. Specific engine concepts, optimized according to thermal efficiency, are rated by their technological availability and scaling to higher powers. A near-term experimental demonstration of the laser heat engine concept appears feasible utilizing an Otto cycle powered by CO<sub>2</sub> laser radiation coupled into the engine through a diamond window. Higher cycle temperatures, higher efficiencies, and scalability to larger sizes appear to be achievable from a laser heat engine design based on the Brayton cycle and powered by a CO laser.

(Author)

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**A79-16634 \* # Photoinduced currents in metal-barrier-metal junctions.** M. P. Guedes, T. K. Gustafson, M. Heiblum, D. P. Siu, C. W. Slayman, J. R. Whinnery (California University, Berkeley, Calif.), and Y. Yasuoka. In: *Radiation energy conversion in space; Conference, 3rd, Moffett Field, Calif., January 26-28, 1978, Technical Papers. (A79-16601 04-44)* New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 524-548. 47 refs. NSF Grant No. ENG-76-84532; Grant No. NsG-2151; Contract No. F44620-76-C-0100.

The fabrication and application of metal-barrier-metal tunneling junctions for radiative interactions are discussed. Particular attention is given to the photolithographic fabrication of small area devices and the coupling to such devices via surface plasmon waves which play an important role at infrared and optical frequencies. It has been shown that the junction electron tunneling currents can be strongly coupled to surface plasmon junction modes, and spontaneous and stimulated emission of the latter are possible as well as nonlinear interactions. Finally, results demonstrating the photo-excitation of electrons with subsequent tunneling induced by ultraviolet radiation are presented. It is estimated that quantum efficiencies of the order of 5% and higher are possible in the ultraviolet region. (Author)

**A79-16637 \* # Laser-enhanced dynamics in molecular rate processes.** T. F. George, I. H. Zimmerman, P. L. DeVries, J. M. Yuan (Rochester University, Rochester, N.Y.), K.-S. Lam, J. C. Bellum, H.-W. Lee, and M. S. Slutsky. In: *Radiation energy conversion in space; Conference, 3rd, Moffett Field, Calif., January 26-28, 1978, Technical Papers. (A79-16601 04-44)* New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 583-592. 16 refs. Grant No. NsG-2198.

The present discussion deals with some theoretical aspects associated with the description of molecular rate processes in the presence of intense laser radiation, where the radiation actually interacts with the molecular dynamics. Whereas for weak and even moderately intense radiation, the absorption and stimulated emission of photons by a molecular system can be described by perturbative methods, for intense radiation, perturbation theory is usually not adequate. Limiting the analysis to the gas phase, an attempt is made to describe nonperturbative approaches applicable to the description of such processes (in the presence of intense laser radiation) as

electronic energy transfer in molecular (in particular atom-atom) collisions; collision-induced ionization and emission; and unimolecular dissociation.

V.P.

**A79-17037 \*** Simple torsion test for shear moduli determination of orthotropic composites. H. T. Sumsion and Y. D. S. Rajapakse (NASA, Ames Research Center, Moffett Field, Calif.). In: ICCM/2; Proceedings of the Second International Conference on Composite Materials, Toronto, Canada, April 16-20, 1978. (A79-16981 05-24) Warrendale, Pa., Metallurgical Society of AIME, 1978, p. 994-1002. 12 refs.

The shear moduli G13 and G23 for two different composites (AS/3501 and T300/5209) of uniaxial and cross-ply fiber orientations were determined by torsion testing of flat specimens of rectangular cross section. Torsion tests were run under controlled angle of twist in an electro-hydraulic servo-controlled test system. Both laser and potentiometer methods of measuring the angle of twist were used. The in-plane shear modulus was calculated with a formula for transversely isotropic materials and a formula for orthotropic materials, while the out-of-plane shear modulus was calculated from the orthotropic material formula. Neither the uniaxial nor the angle-ply composite materials studied were transversely isotropic. The degree of anisotropy for the angle-ply materials was several times greater than that of the uniaxial composites. For specimens of uniaxial fiber orientation, the in-plane shear moduli could be calculated to a good approximation by using the isotropic formula and test machine deflection data.

P.T.H.

**A79-17673 \* #** Space Shuttle Orbiter thermal protection material development and testing. H. K. Larson and H. E. Goldstein (NASA, Ames Research Center, Entry Technology Branch, Moffett Field, Calif.). In: Aerospace Testing Seminar, 4th, Los Angeles, Calif., March 2, 3, 1978, Proceedings. (A79-17651 05-12) Mt. Prospect, Ill., Institute of Environmental Sciences, 1978, p. 189-194. 7 refs.

The research work described in the present paper was carried out to develop and evaluate thermal protection materials for application to the Space Shuttle and future programs. The philosophy, methodology of testing, and facilities are discussed which had to be developed in view of the new requirements placed on the thermal protection system, in particular the requirement of multiple flight capability.

V.P.

**A79-18303 \*** Modeling aerosol losses and clothing effects in fires. D. E. Cagliostro (NASA, Ames Research Center, Chemical Research Projects Office, Moffett Field, Calif.). *Journal of Fire and Flammability*, vol. 9, Oct. 1978, p. 535-552. 10 refs.

The described modification of a physiochemical fire model predicts physical effects in clothed humans exposed to elevated temperatures as well as gas and aerosol concentrations in the atmosphere of an aerospace vehicle. The modifications involve the reduction in aerosol concentrations caused by settling and some improvements in dealing with mass and heat transfer effects. Predicted skin temperatures are found to be within 2°C of experimental values for the cases studied, and model predictions of total body enthalpy seem to correlate with symptomology observed experimentally.

M.L.

**A79-18321 \*** SSTs, nitrogen fertilizer and stratospheric ozone. R. P. Turco (R & D Associates, Marina del Rey, Calif.), R. C. Whitten, I. G. Poppoff (NASA, Ames Research Center, Moffett Field, Calif.), and L. A. Capone (San Jose State University, San Jose, Calif.). *Nature*, vol. 276, Dec. 21-28, 1978, p. 805-807. 20 refs.

A recently revised model of the stratosphere is used to show that a substantial enhancement in the ozone layer could accompany worldwide SST fleet operations and that water vapor may be an important factor in SST assessments. Revised rate coefficients for various ozone-destroying reactions are employed in calculations which indicate a slight increase in the total content of stratospheric

ozone for modest-sized fleets of SSTs flying below about 25 km. It is found that water-vapor chemical reactions can negate in large part the NO<sub>x</sub>-induced ozone gains computed below 25 km and that increased use of nitrogen fertilizer might also enhance the ozone layer.

F.G.M.

**A79-18547 \*** A shock-tube measurement of the SiO/E 1 Sigma + - X 1 Sigma +/ transition moment. C. Park (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 20, Nov. 1978, p. 491-498. 13 refs.

The sum of the squares of the electronic transition moments for the (E 1 Sigma +) - (X 1 Sigma +) band system of SiO has been determined from absorption measurements conducted in the reflected-shock region of a shock tube. The test gas produced by shock-heating a mixture of SiCl<sub>4</sub>, N<sub>2</sub>O, and Ar, and the spectra were recorded photographically in the 150-230-nm wavelength range. The values of the sum of the squares were determined by comparing the measured absorption spectra with those produced by a line-by-line synthetic spectrum calculation. The value so deduced at an r-centroid value of 3.0 bohr was 0.86 ± 0.10 atomic unit. (Author)

**A79-18564 \* #** Monte Carlo solution of Boltzmann equation for a simple model of highly nonequilibrium diatomic gases - Translational rotational energy relaxation. K. K. Yoshikawa (NASA, Ames Research Center, Moffett Field, Calif.). *Tokyo, University, Institute of Space and Aeronautical Science, Report no. 560*, vol. 43, June 1978, p. 73-110. 18 refs.

Theoretical results pertaining to internally excited translational-rotational energy relaxation in a spatially uniform diatomic gas far removed from solid boundaries are obtained by solving the Boltzmann equation by means of the Monte Carlo direct simulation method. The analysis is based on calculations involving three different types of initial conditions: equilibrium, nonequilibrium-equipartition (i.e., equipartition is satisfied, but the distributions are perturbed), and nonequilibrium-nonequipartition (i.e., both equipartition and the distributions are perturbed). Results of monatomic-gas simulations are also included to facilitate comparisons with the coupled translational-rotational relaxation simulations, and some simulations for a normal shock-wave structure are briefly examined. The results show that: (1) single-step transitions are the significant mechanisms of intermodal energy transfer; (2) translational-rotational transitions are coupled most efficiently for low-lying states of rotationally excited molecules and least efficiently for highly rotationally excited molecules; and (3) relaxation occurs via a successive set of distributions that are not Maxwell-Boltzmann (nonlocal Maxwellian).

F.G.M.

**A79-18862 \*** Contribution of tidal dissipation to lunar thermal history. S. J. Peale (California, University, Santa Barbara, Calif.) and P. Cassen (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). *Icarus*, vol. 36, Nov. 1978, p. 245-269. 40 refs. Grants No. NGR-05-010-062; No. NCA2-OR680-701.

Possible contributions of tidal heating to the thermal history of the moon are investigated, and conditions under which such heating would have been an important factor in the evolution of the moon are defined as precisely as possible within the bounds of the uncertainties. The tidal dissipation is defined as a function of position in the moon and of the earth-moon separation for a homogeneous incompressible moon. Results for the dissipation are given for eccentricities of zero and 0.055 as well as for the lunar obliquity as determined by the equilibrium Cassini states. Possible orbital resonances which interrupt the assumed simplified expansion of the lunar orbit are considered, along with radial variations in rigidity. The dissipation in a two-layer model moon with a molten inner core and an outer mantle with the moon's present rigidity is determined, and implications of the results for the role of tidal heating in the history of the moon are discussed.

F.G.M.

**A79-18900 \*** Near-infrared energy distributions of M31. B. J. Taylor (NASA, Ames Research Center, Moffett Field, Calif.). *Astronomical Journal*, vol. 83, Nov. 1978, p. 1377-1382. 17 refs.

Spectrophotometric data obtained by comparing Spinrad-Taylor (1969) standards with Alpha Lyr are presented, along with a calibration of these data for wavelengths longward of 6000 Å. M31 sky measurements made 1 deg south of the nucleus at five wavelengths between 6040 and 10,360 Å, inclusive, are compared with near-IR spectrophotometry performed by Spinrad and Taylor (1971), Oke and Schwarzschild (1975), and O'Connell (1976). Agreement and discrepancies among the different data sets are discussed. Some possible explanations of the differences are discounted, and tests are performed which reveal no effects of error in mean extinction and brightness-dependent wavelength response. F.G.M.

**A79-18984 \*** The distribution of S IV and Ne II in NGC 7027. J. D. Bregman (NASA, Ames Research Center, Space Sciences Div., Moffett Field; Lick Observatory, Santa Cruz, Calif.). *Astronomical Society of the Pacific, Publications*, vol. 90, Oct.-Nov. 1978, p. 548-551. 13 refs.

Results are reported for measurements of the S IV 10.5-micron and Ne II 12.8-micron IR emission lines at four positions in NGC 7027 and of the Ar III 9.0-micron line at one position in the same planetary nebula. Ionic abundances are calculated using the data obtained at one position and are combined with published optical data for other ionization states to obtain total elemental abundances. The S IV and Ne II line-intensity distributions are compared with an 8.1-GHz radio map of the nebula. The S IV distribution indicates a density of about 500,000 per cu cm, and the Ne II is found to be contained in low-ionization regions distributed inhomogeneously throughout the nebula. The total abundances relative to hydrogen are determined to be 0.000015 for S, 0.000053 for Ne, and 0.000007 for Ar; these abundances are shown to be within the range of published average values for planetary nebulae. F.G.M.

**A79-19071 \*** Nitrogen-sulfur compounds in stratospheric aerosols. N. H. Farlow, K. G. Snetsinger (NASA, Ames Research Center, Moffett Field, Calif.), D. M. Hayes, H. Y. Lem (LFE Corp., Environmental Analysis Laboratories Div., Richmond, Calif.), and B. M. Tooper (EMS Laboratories, Hawthorne, Calif.). *Journal of Geophysical Research*, vol. 83, Dec. 20, 1978, p. 6207-6211. 20 refs.

Two forms of nitrosyl sulfuric acid ( $\text{NOHSO}_4$  and  $\text{NOHS}_2\text{O}_7$ ) have been tentatively identified in stratospheric aerosols. The first of these can be formed either directly from gas reactions of  $\text{NO}_2$  with  $\text{SO}_2$  or by gas-particle interactions between  $\text{NO}_2$  and  $\text{H}_2\text{SO}_4$ . The second product may form when  $\text{SO}_3$  is involved. Estimates based on these reactions suggest that the maximum quantity of NO that might be absorbed in stratospheric aerosols could vary from one-third to twice the amount of NO in the surrounding air. If these reactions occur in the stratosphere, then a mechanism exists for removing nitrogen oxides from that region by aerosol particle fallout. This process may typify another natural means that helps cleanse the lower stratosphere of excessive pollutants. (Author)

**A79-19448 \*** Opacified silica reusable surface insulation /RSI/ for thermal protection of the Space Shuttle Orbiter. H. E. Goldstein, M. Smith, D. Stewart (NASA, Ames Research Center, Moffett Field, Calif.), and D. B. Leiser (NASA, Ames Research Center, Moffett Field; Stanford University, Stanford, Calif.). In: *Thermal conductivity 15*. New York, Plenum Publishing Corp., 1978, p. 335-341.

A reusable surface insulation (RSI) material adopted for use on limited areas of the Orbiter's heat shield is described. The RSI is a rigid sintered fibrous silica material containing about 3% by weight of 1200-grit silicon carbide powder. RSI manufacture is described; strength characteristics and thermal conductivity of the final product can be tailored by controlling the isotropy, and the density, coefficient of thermal expansion, and specific heat are reported. Data establishing that opacification of RSI with silicon carbide lowers the thermal conductivity are presented. M.L.

**A79-19471 \*** Computation of three-dimensional turbulent separated flows at supersonic speeds. C. C. Horstman and C. M. Hung (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0002*. 12 p. 17 refs.

Numerical solutions of the time-averaged Navier-Stokes equations employing a simple eddy-viscosity model have been obtained for three dimensional turbulent flow fields at supersonic speeds. The computer results are compared with a series of experimental test flows describing the interaction of a swept shock wave with a turbulent boundary layer for various shock-wave strengths. Very good agreement is obtained between the computed and experimental surface and flow-field results. The computed flow fields are examined in detail to investigate the physics of this type of flow field. Questions concerning the existence of a vortex and the relationship between converging surface oil streaks and the resulting flow field are addressed. (Author)

**A79-19475 \*** Numerical solution of the azimuthal-invariant thin-layer Navier-Stokes equations. C. J. Nietubicz (U.S. Army, Ballistics Research Laboratory, Aberdeen Proving Ground, Md.), T. H. Pulliam, and J. L. Steger (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0010*. 11 p. 14 refs.

The paper reports a numerical procedure developed for a two-dimensional azimuthal (or planar) invariant form of the thin-layer Navier-Stokes equations. Generalization of the governing equations is described, and the equations are solved with an implicit approximate factorization finite-difference scheme. Inviscid and viscous results are presented for both external and internal flows and for spinning and nonspinning bodies. M.L.

**A79-19521 \*** Design of transonic airfoil sections using a similarity theory. D. Nixon (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0076*. 8 p. 16 refs.

In the present paper, it is shown that numerical optimization is a powerful tool for designing transonic wings and airfoils. Nixon's (1978) similarity theory is extended to cover design optimization problems. Some ground rules for designing shock-free airfoils are proposed and their application is demonstrated by examples. Advantages which accrue from integrating similarity theory into the numerical optimization procedure are noted. V.P.

**A79-19553 \*** Calculation of transonic aileron buzz. J. L. Steger and H. E. Bailey (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0134*. 13 p. 15 refs.

An implicit finite-difference computer code that uses a two-layer algebraic eddy viscosity model and exact geometric specification of the airfoil has been used to simulate transonic aileron buzz. The calculated results, which were performed on both the Illiac IV parallel computer processor and the Control Data 7600 computer, are in essential agreement with the original expository wind-tunnel data taken in the Ames 16-Foot Wind Tunnel just after World War II. These results and a description of the pertinent numerical techniques are included. (Author)

**A79-19635 \*** Optimal nodal point distribution for improved accuracy in computational fluid dynamics. B. L. Pierson (Iowa State University of Science and Technology, Ames, Iowa) and P. Kutler (NASA, Ames Research Center, Computational Fluid Dynamics Branch, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0272*. 9 p. 9 refs. Grant No. NCA2-OR340-705.

In applying finite-difference techniques to flow field problems, the accuracy attained for a fixed number of node points can be improved using unequally-spaced node points. The distribution of these node points is chosen here by minimizing a measure of local truncation error with respect to the parameters which define a transformation between the computational space of equally-spaced node points and the physical space of unequally-spaced node points. The problem then becomes a nonlinear programming problem. Numerical results are presented for two one-dimensional problems: the Blasius boundary layer problem and the inviscid Burgers' equation. (Author)

**A79-19639 \*** Techniques for correcting approximate finite difference solutions. D. Nixon (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0277*. 8 p.

A method of correcting finite-difference solutions for the effect of truncation error or the use of an approximate basic equation is presented. Applications to transonic flow problems are described and examples given. (Author)

**A79-20151 \*** Cosmology of a charged universe. A. Barnes (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). *Astrophysical Journal, Part 1*, vol. 227, Jan. 1, 1979, p. 1-12. 19 refs.

The Proca generalization of electrodynamics admits the possibility that the universe could possess a net electric charge uniformly distributed throughout space, while possessing no electric field. A general-relativistic model of cosmological expansion dominated by such a charged background has been calculated, and is consistent with present observational limits on the Hubble constant, the deceleration parameter, and the age of the universe. However, if this cosmology applied at the present epoch, the very early expansion of the universe would have been too rapid for cosmological nucleosynthesis or thermalization of the background radiation to have occurred. Hence, domination of the present expansion by background charge appears to be incompatible with the 3-K background and big-bang production of light elements. If the present background charge density were sufficiently small (but not strictly zero), expansion from the epoch of nucleosynthesis would proceed according to the conventional scenario, but the energy due to the background charge would have dominated at some earlier epoch. This last possibility leads to equality of pressure and energy density in the primordial universe. (Author)

**A79-20187 \*** On the CH4 nu-4 fundamental controversy - Line-intensity measurements revisited. B. L. Lutz (Lowell Observatory, Flagstaff, Ariz.; New York, State University, Stony Brook, N.Y.), R. W. Boese (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.), and P. M. Silvaggio. *Astrophysical Journal, Part 1*, vol. 227, Jan. 1, 1979, p. 334-337. 5 refs. Grants No. NCA2-OR760-801; No. NGR-03-003-001.

Because of the controversy over the value of the band strength for the nu-4 fundamental of CH<sub>4</sub>, equivalent widths of the R(0), R(1), and P(11, 11, F<sub>1</sub>) lines have been measured to compare with opposing views. The present measurements are consistent with the band strength of Ko and Varanasi (1977), who, on the basis of high-resolution line-strength measurements, propose an integrated band strength of 145 kaysers/(cm·am). (Author)

**A79-20733 \*** Small mass spectrometer with extended measurement capabilities at high pressures. U. von Zahn (Bonn, Universitat, Bonn, West Germany) and K. Mauersberger (Minnesota University, Minneapolis, Minn.). *Review of Scientific Instruments*, vol. 49, Nov. 1978, p. 1539-1542. 11 refs. Bundesministerium fur Forschung und Technologie Contract No. WKR-275; Contract No. NAS2-8812.

For the in situ investigation of planetary atmospheres a small Mattauch-Herzog mass spectrometer has been developed. Its high-pressure performance has been improved by incorporating differential pumping between the ion source and the analyzing fields, shortening the path-length as well as increasing the extraction field in

the ion source. In addition doubly ionized and dissociated ions are used for mass analysis. These measures make possible operation up to 0.01 millibars. Results of laboratory tests related to linearity, dynamic range, and mass resolution are presented, in particular for CO<sub>2</sub>. (Author)

**A79-20820 \*** The estimation of residual strength of composites by acoustic emission. A. Rotem (NASA, Ames Research Center, Materials and Physical Sciences Branch, Moffett Field, Calif.; Technion - Israel Institute of Technology, Haifa, Israel). In: *Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978*. (A79-20801 07-23) Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 329-353. 5 refs.

The strength of unidirectional fibrous composite materials was measured as a function of the acoustic emission. Specimens of glass fibers and carbon fibers in an epoxy matrix were tested to fracture. Many of the specimens were with existing defects. It was shown, analytically and experimentally, that defective material starts to emit acoustic waves at a much lower stress level than nondefective material. It was found that for glass fiber material, the ultimate strength of the composite is proportional to the stress level for which a specific number of acoustic emission counts was reached. For carbon fiber material, this phenomenon is less pronounced. (Author)

**A79-20855 \*** Characterization of flammability properties of some thermoplastic and thermoset resins. D. A. Kourties and J. A. Parker (NASA, Ames Research Center, Moffett Field, Calif.). In: *Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978*. (A79-20801 07-23) Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 893-912. 31 refs.

The thermochemical and flammability properties of some thermally stable polymers considered for use in aircraft interiors are described. The properties studied include: (1) thermomechanical properties such as glass transition and melt temperature; (2) dynamic thermogravimetric analysis in anaerobic environment; (3) flammability properties such as oxygen index, flame spread, and smoke evolution; and (4) selected physical properties. The thermoplastic polymers evaluated included polyphenylene sulfide, polyarylsulfone, 9,9-bis(4-hydroxyphenyl)-fluorene polycarbonate-poly(dimethylsiloxane) and polyether sulfone. The thermosets evaluated included epoxy, bismaleimide, a modified phenolic and polyaromatic melamine resin. These resins were primarily used in the fabrication of glass reinforced preps for the construction of experimental panels. Test results and relative rankings of some of the flammability parameters are presented and the relationship of the molecular structure, char yield, and flammability properties of these polymers are discussed. (Author)

**A79-21029 \*** Scattering by non-spherical particles of size comparable to a wavelength - A new semi-empirical theory. J. B. Pollack and J. N. Cuzzi (NASA, Ames Research Center, Moffett Field, Calif.). In: *Conference on Atmospheric Radiation, 3rd, Davis, Calif., June 28-30, 1978, Preprints*. (A79-21026 07-47) Boston, Mass., American Meteorological Society, 1978, p. 20-23. 14 refs.

Mie theory, which is generally used to describe the scattering behavior of particles at a certain wavelength, is only rigorously correct for spherical particles. Particles found as atmospheric constituents, with the exception of cloud droplets, are, however, decidedly nonspherical. An investigation is, therefore, conducted regarding the significant ways in which the scattering behavior of irregularly shaped particles differs from that of spheres. A systematic method is formulated for treating the real scalar scattering behavior. A description is presented of a new semiempirical theory, based on simple physical principles and data obtained in laboratory measurements, which successfully reproduces the single scattering phase function for a wide range of particle shapes, sizes, and refractive indices. G.R.

**A79-21080 \*** Remote sensing of aerosols in the Martian atmosphere - Implications for terrestrial studies. J. B. Pollack and D. Colburn (NASA, Ames Research Center, Moffett Field, Calif.). In: Conference on Atmospheric Radiation, 3rd, Davis, Calif., June 28-30, 1978, Preprints. (A79-21026 07-47) Boston, Mass., American Meteorological Society, 1978, p. 217, 218. 7 refs.

Data provided by recent spacecraft missions to Mars include determinations of the properties and effects of aerosols suspended in the Martian atmosphere. Comparison of alternative procedures used to remotely sense the aerosol properties as well as analyses of these methodologies may have relevance for analogous procedures being developed to study terrestrial aerosols with satellite-borne sensors. In addition, Martian aerosols appear to have played a role in climate changes that may have terrestrial counterparts. Of particular concern are observations made from the Mariner 9 orbiter spacecraft, which studied Mars during 1971 and 1972, and the Viking orbiter and lander spacecraft, which conducted measurements commencing in the middle of 1976 and continuing through the present. Two global dust storms were observed from their commencement to their demise. G.R.

**A79-21103 \*** Possible effects of solar UV variations on ozone and climate. J. B. Pollack, W. Borucki, and O. B. Toon (NASA, Ames Research Center, Moffett Field, Calif.). In: Conference on Atmospheric Radiation, 3rd, Davis, Calif., June 28-30, 1978, Preprints. (A79-21026 07-47) Boston, Mass., American Meteorological Society, 1978, p. 313, 314. 6 refs.

A one-dimensional photochemical model was used to estimate the consequences of 27-day, 11-year, 22-year, and several-hundred-year variations of ultraviolet solar radiation on the concentration of ozone and nitrogen dioxide, and a one-dimensional radiative-convective equilibrium model was used to assess the joint effect of the radiation and concentration variations on the global temperature structure. For the several-hundred-year variations, the ozone column density increases by about 17.5% from minimum to maximum solar UV flux. For the 11-year period the ozone column density fluctuates by only about 7%, the lack of a full response being due to the time required for vertical motions to redistribute ozone from the altitudes of maximum production to those of maximum steady-state value. The 22-year period shows a full response, which the density varies by less than a percent for the 27-day period. Climatic consequences of these results are briefly discussed. P.T.H.

**A79-21348 \*** Spectroscopic study of photosensitized oxidation of 1,4-polybutadiene. M. A. Golub, R. V. Gemmer, and M. L. Rosenberg (NASA, Ames Research Center, Moffett Field, Calif.). In: Stabilization and degradation of polymers. Washington, D.C., American Chemical Society (Advances in Chemistry Series, No. 169), 1978, p. 11-18. 15 refs.

**A79-21364 \*** Observations of secondary spectrophotometric standards in the wavelength range between 5840 and 10800 Å. B. J. Taylor (NASA, Ames Research Center, Moffett Field; San Jose State University, San Jose, Calif.). *Astronomical Journal*, vol. 84, Jan. 1979, p. 96-100. 25 refs.

Twenty-three stars that are suitable for use as secondary spectrophotometric standards are compared with Alpha Lyrae in the wavelength range between 5840 Å and 1.1 microns. The consistency of the present data with previously existing measurements is discussed, along with the reliability of the present data. It is found that there is good agreement with previous data in some cases, but moderate or substantial discrepancies are exhibited in others. It is suggested that extinction variation is the most probable cause of the discrepancies, and observational procedures that may improve the situation with regard to the discrepancies are proposed. F.G.M.

**A79-22774 \*** Thermochemical characterization of some thermally stable thermoplastic and thermoset polymers. D. A. Kourtidis, W. J. Gilwee, Jr., and J. A. Parker (NASA, Ames Research Center, Moffett Field, Calif.). *Polymer Engineering and Science*, vol. 19, Jan. 1979, p. 24-29. 31 refs.

The thermochemical and flammability properties of some thermally stable polymers considered for use in aircraft interiors are

described. The properties studied include: (1) thermomechanical properties such as glass transition and melt temperature; (2) dynamic thermogravimetric analysis in anaerobic environment; (3) flammability properties such as oxygen index, flame spread, and smoke evolution; and (4) selected physical properties. The thermoplastic polymers evaluated include polyphenylene sulfide, polyarylsulfone, 9,9-bis(4-hydroxyphenyl)-fluorene polycarbonate-poly(dimethylsiloxane) and polyether sulfone. The thermoset polymers evaluated include epoxy, bisnaleimide, a modified phenolic, and polyaromatic melamine resin. These resins were primarily used in the fabrication of glass-reinforced preprints for the construction of experimental panels. Test results and relative rankings of some of the flammability parameters are presented, and the relationship of the molecular structure, char yield, and flammability properties of these polymers are discussed. (Author)

**A79-22787 \*** Further observational support for the lossy radial diffusion model of the inner Jovian magnetosphere. C. K. Goertz, J. A. Van Allen, and M. F. Thomsen (Iowa, University, Iowa City, Iowa). *Journal of Geophysical Research*, vol. 84, Jan. 1, 1979, p. 87-92. 22 refs. NSF Grant No. ATM-76-82739; Contract No. NAS2-6553.

A mathematical model describing radial diffusion, with violation of the third adiabatic invariant and with local losses, is applied to the Pioneer 10 and 11 observations of omnidirectional integral intensities of electrons with energy exceeding 21 MeV. Local losses outside  $L = 3$  are much stronger than synchrotron losses but weaker than the losses one would expect for strong pitch angle diffusion. If radial diffusion is driven by ionospheric winds, as was suggested by Brice and McDonough (1973), it is found that the theoretical solution which best fits the data requires that the radial diffusion coefficient equals  $3 \times 10$  to the -9th L-cubed/s and the lifetime against local losses is approximately a few million seconds. (Author)

**A79-22814 \*** On the phase relationship between the energetic particle flux modulation and current disc penetrations in the Jovian magnetosphere - Pioneer 10 inbound. D. E. Jones (Brigham Young University, Provo, Utah). *Geophysical Research Letters*, vol. 6, Jan. 1979, p. 45-48. 21 refs. Contract No. NAS2-7358; Grant No. NSG-2082.

The surface defined by the locus of field minima along field lines for an unterminated Jovian model magnetosphere is found to coincide with the surface of the model current disk which provides a good fit to the data. However, when the model is terminated by means of magnetopause currents, preservation of the fit by modifying the current distribution near the outer edge of the disk causes the minimum absolute magnetic field surface to bifurcate. Energetic electron flux time profiles that are based upon such a minimum absolute magnetic field configuration are found to be qualitatively consistent with the inbound Pioneer 10 data. (Author)

**A79-22861 \*** Quantitative energy extraction measurements in a photoionization-stabilized self-sustained XeF laser. C. M. Lee, V. Hasson, P. D. Rowley, and R. Exberger (NASA, Ames Research Center, Moffett Field, Calif.). *Applied Physics Letters*, vol. 34, Jan. 1, 1979, p. 56-58. 8 refs.

Detailed time-correlated gain, fluorescence, and laser energy measurements were used to obtain quantitative data on energy extraction efficiencies for a photoionization-stabilized self-sustained XeF laser. A current pulse of 25 ns full width at half-maximum produced an 80-cu-cm XeF plasma in NF<sub>3</sub>:Xe:He gas mixtures with a maximum output energy of 80 mJ. The results show that the maximum small-signal gain and the maximum specific output energy is proportional to the NF<sub>3</sub> content of the gas mixture. This suggests that there is an optimum fractional utilization of the NF<sub>3</sub> molecules in the discharge. Under high-gain conditions, 30-40% of the energy stored in XeF (asterisk) can be extracted in a gain-switched pulse. The output energy represents less than 1% of the input energy. (Author)

**A79-23183 \*** Six collapses. R. H. Miller (Chicago, University, Chicago, Ill.) and B. F. Smith (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.).

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*Astrophysical Journal, Part 1*, vol. 227, Jan. 15, 1979, p. 407-414. 11 refs. Grant No. NCA2 JR108-801.

The self-consistent dynamical development of six stellar systems, started from rotating spherical configurations, has been studied by means of a fully three-dimensional n-body integration. The six examples had different initial angular velocities and velocity dispersions. All settled down into prolate bars rotating about a short axis within two initial rotation periods. The bars are long-lived, robust, and stable. Bars are the natural form toward which rapidly rotating stellar dynamical systems develop, instead of the flattened axisymmetric disks that had been expected. The early stages of each collapse are reasonably well described by a theoretical model according to which a collapse passes through a sequence of rigidly rotating, uniform-density spheroids. The first significant departures from spheroidal form were axisymmetric in all cases. Rings formed in some examples, sheets in others, with transition cases between these extremes. Nonaxisymmetric forms developed from these intermediate stages. (Author)

**A79-23508 \* #** **Simulation of three-dimensional compressible viscous flow on the ILLiac IV computer.** T. H. Pulliam and H. Lomax (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0206.* 10 p. 11 refs.

Complicated three-dimensional viscous transonic flows about bodies at high angles of attack are solved on the ILLiac IV computer. It is shown that certain approximate forms of the compressible Reynolds-averaged Navier-Stokes equations can be computed about realistic three-dimensional geometries with relative ease on the ILLiac IV. The ease and efficiency with which this can be done depend on the approximations made in the basic equations, the choice of the numerical algorithm used for the solution, and the data-base system that controls the data management and identifies and manipulates the vectors. A pencil data-base system is found to be particularly suitable for the approximations and numerical method chosen to produce the results presented. In addition, some comparisons are periodicity in its cross-correlation. This result was attributed to the flat-topped, aft-cambered shape of the supercritical airfoil section, which reduced the coupling between shock oscillations and lift fluctuations. (Author)

**A79-23515 \* #** **Computational aerodynamics development and outlook /Dryden Lecture in Research for 1979.** D. R. Chapman (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0129.* 30 p. 150 refs.

Some past developments and current examples of computational aerodynamics are briefly reviewed. An assessment is made of the requirements on future computer memory and speed imposed by advanced numerical simulations, giving emphasis to the Reynolds averaged Navier-Stokes equations and to turbulent eddy simulations. Experimental scales of turbulence structure are used to determine the mesh spacings required to adequately resolve turbulent energy and shear. Assessment also is made of the changing market environment for developing future large computers, and of the projections of microelectronics memory and logic technology that affect future computer capability. From the two assessments, estimates are formed of the future time scale in which various advanced types of aerodynamic flow simulations could become feasible. Areas of research judged especially relevant to future developments are noted. (Author)

**A79-23517 \* #** **Computation of supersonic viscous flows over ogive-cylinders at angle of attack.** J. V. Rakich, Y. C. Vigneron, and R. Agarwal (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0131.* 10 p. 19 refs. Grant No. NGR-16-002-038.

The parabolic Navier-Stokes (PNS) marching finite-difference method is applied to 3-D viscous flow over pointed ogive-cylinders, and to turbulent flow over a cone. Ogive computations were

performed using the new technique recently reported by Vigneron, Rakich, and Tannehill. Comparison is made with experiment and inviscid computations. The present results show that this method, which neglects part of the pressure gradient in the x-momentum equation, is nevertheless valid for flows with a strong favorable pressure gradient. In addition, turbulent separated flow over a cone has been computed using the older PNS code due to Lubard and Hellwell. It is found that one must freeze the turbulent eddy-viscosity model upstream of 3-D separation to get agreement with experiment. (Author)

**A79-23519 \* #** **Pseudo-direct solution to the boundary-layer equations for separated flow.** R. Arieli and J. D. Murphy (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0139.* 11 p. 16 refs.

This paper describes a procedure for the automatic iteration of an inverse boundary-layer technique to a prescribed pressure distribution in a separated flow. The technique is demonstrated by computation of two transonic airfoil flows and two externally generated shock boundary-layer interaction flows. These results are compared to experimental data and to solutions of the full Navier-Stokes equations. These comparisons indicate that substantial economies can be obtained by applying methods like the present, in lieu of full Navier-Stokes methods, in zonal calculation schemes for design purposes. The optimization technique leading to convergence is described in detail and a table of typical computation time is presented. (Author)

**A79-23530 \* #** **Shock tube spectroscopy of C3 + C2H mixture in the 140 to 700 nm range.** S. G. Prakash (Stanford University, Stanford, Calif.) and C. Park (NASA, Ames Research Center, Entry Technology Branch, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0094.* 8 p. 14 refs.

Absorption spectroscopy has been performed in the reflected-shock region of a shock tube. Acetylene was shock-heated to produce a mixture, at around 4000 K, rich in C3 and C2H to simulate the ablation layer over the Jovian entry probe, and the spectral range from 140 to 700 nm was surveyed with an evacuable spectrograph. The observed spectra were dominated by those of C2 and C3 and an unknown band at wavelengths below 300 nm. The cross sections of the C3 Swings band in the 300 to 450 nm range agreed with previous measurements within a factor of 1.5. No absorption was observed in the wavelength range from 550 to 700 nm. The unknown broadband absorption with a peak cross section of 4 times 10 to the minus 17/sq cm at around 170 nm was attributed tentatively to the C2H radical. A preliminary calculation showed that the newly found absorption band would reduce the radiative heat flux to the stagnation point wall by about 12.5% in a typical flight condition. (Author)

**A79-23539 \* #** **Experimental studies of radiative base heating of a Jovian entry model.** H. Shirai (NASA, Ames Research Center, Moffett Field, Calif.), Gumma University, Maebashi, Japan) and C. Park (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0038.* 12 p. 8 refs.

A scale model of the Jovian entry vehicle of 6.4 cm diameter is tested in an electric arc-driven shock tube while a sphere model of 5 cm diameter is tested in a combustion-driven shock tube and an electric arc-driven shock tunnel. The radiative heat-transfer rate and pressure on the front and the base regions are measured in the absence of ablation with sensors imbedded in the models in a stream consisting of 10% hydrogen in a bath of either neon or argon. The measured radiative heat-transfer rates and pressures add up to about 22 kW/sq cm and 12 atm, respectively, at the front stagnation point. The ratio of the base-to-stagnation-point radiative heat transfer rates is found to be about 1/4 for the sphere at Mach 1.8, about 1/30 for the sphere at Mach 4.8, and about 1/6 for the scale model at Mach 1.7. When the effects of model geometry and Mach number are accounted for, the present experimental results agree well with the theoretical prediction of Park. (Author)

**A79-23540 \* # Modeling of radiative heating of base region of Jovian entry probe.** C. Park (NASA, Ames Research Center, Entry Technology Branch, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0039.* 14 p. 21 refs.

The mechanism of radiative heating of the afterbody region of Jovian entry probe is analyzed. A theoretical model is derived to determine the average thermodynamic properties in the expanding region, recirculating region, recompression region, and neck region through application of one-dimensional conservation equations. Flow parameters are obtained from the shadowgraphs of a free-flight test. Radiative transfer is calculated using spectrally detailed computer codes accounting for nonequilibrium. The results show that the most severe heating occurs immediately behind the frustum, and that the recompression and neck regions are the major sources of radiation that heats the base stagnation point. The radiation flux to the base point is slightly stronger with ablation than without, its value being  $0.11(43Pb/Ps)^2$  times that to the front stagnation point, where  $Pb/Ps$  is the ratio of base-to-front stagnation point pressures and its value is in the range 0.023-0.066. The time-integrated heat load to the base point is  $18(43Pb/Ps)^2$  kJ/sq cm. Existing experimental data are shown to agree with the theoretical prediction. (Author)

**A79-23541 \* # Effects of turbulence model selection on the prediction of complex aerodynamic flows.** T. J. Coakley and M. Y. Bergmann (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0070.* 20 p. 18 refs.

Numerical simulations of viscous transonic flow over a circular-arc airfoil and in a diffuser are described. The simulations are made with a new computer program designed to serve as a tool in the development of improved turbulence models for complex flows. The program incorporates zero-, one-, and two-equation eddy viscosity models and includes a variety of subsonic and supersonic boundary conditions. The airfoil flow contains a shock-separated boundary-layer interaction that has resisted previous attempts at simulation. The diffuser flow also contains a shock-boundary-layer interaction, which has not been simulated previously. Calculations using standard turbulence models, developed originally for incompressible unseparated flows, are described. Results indicate that although there are interesting differences in predictions between the various models, none of them predict the flows accurately. Suggestions for improved turbulence models are discussed. (Author)

**A79-23542 \* # On turbulence modeling for unsteady transonic flows.** J. G. Marvin, L. L. Levy, Jr., and H. L. Seegmiller (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0071.* 16 p. 18 refs.

A detailed examination of the turbulent field in an unsteady transonic flow undergoing shock-induced separation is conducted. Ensemble-averaged mean and fluctuating velocities, obtained from conditionally sampled laser velocimeter data, are described and analyzed to assess the applicability of modeling concepts usually employed in steady-flow problems. Some comparisons with computations employing the Reynolds averaged Navier-Stokes equations with a mixing length turbulence model are then presented to illustrate the status of current predictive capabilities. The results appear to imply that turbulence models developed for steady flows apply and that the model need not reflect all the fine details of the turbulent structure but rather account in an approximate way for the production and destruction of the turbulence. G.R.

**A79-23692 \* # Fast, conservative schemes for the full potential equation applied to transonic flows.** T. L. Holst (NASA, Ames Research Center, Moffett Field, Calif.) and W. F. Ballhaus (NASA, Ames Research Center, U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). *AIAA Journal*, vol. 17, Feb. 1979, p. 145-152. 10 refs.

Implicit approximate factorization techniques (AF) are investi-

gated for the solution of matrix equations resulting from finite-difference approximations to the full potential equation in conservation form. For transonic flows, an artificial viscosity, required to maintain stability in supersonic regions, is introduced by an upwind bias of the density. Two implicit AF procedures are presented, and their convergence performance is compared with that of the standard transonic solution procedure: successive line overrelaxation (SLOR). Subcritical and supercritical test cases are considered. Results indicate a substantial improvement in convergence rate for AF schemes relative to SLOR. (Author)

**A79-23694 \* # Transient thermal response of ablating bodies** N. Arai (NASA, Ames Research Center, Moffett Field, Calif.) and K.-I. Karashima (Tokyo, University, Tokyo, Japan). *AIAA Journal*, vol. 17, Feb. 1979, p. 191-195. 26 refs.

A numerical study of transient thermal response of a blunted axisymmetric body made of Teflon is presented using a two-layer thermal model. It is shown that phase change and transverse heat conduction have a considerable effect on the internal temperature field. Comparison of the numerical results with experimental data shows that the single-layer thermal model does not predict the real failure of the thermal field, whereas the results of the two-layer thermal model agree reasonably well with the experiment. (Author)

**A79-23853 \* # Production and analysis of thermal decomposition products from polymeric materials.** D. A. Chatfield (Utah, University, Salt Lake City, Utah; San Diego State University, San Diego, Calif.), I. N. Einhorn, F. D. Hileman, J. H. Futrell, and K. J. Voorhees (Utah, University, Salt Lake City, Utah). In: *Experimental diagnostics in combustion of solids*. (A79-23851 08-25) New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 49-75. 22 refs. Research supported by the Hercules, Inc.; NSF Grant No. GI-33650; Contract No. NAS2-8244.

A description is presented of a strategy for analyzing the combustion process and the degradation products which are formed. One of three primary objectives in the study of polymer degradation is related to the characterization of the material to be studied and the investigation of the thermal behavior of the material. Another objective is concerned with the definition of the nature of the decomposition process by identification and quantitation of the degradation products. The third objective involves the determination of the mechanism and kinetics of the decomposition process. The methods of sample degradation include pyrolysis, oxidative degradation, flaming combustion, and the use of large-scale combustion chambers. Methods of chemical separation and identification are considered, taking into account low-boiling volatiles, high-boiling volatiles, and ancillary techniques. G.R.

**A79-23909 \* # Dynamics of a stellar bar.** R. H. Miller and B. F. Smith (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.; Chicago, University, Chicago, Ill.). *Astrophysical Journal, Part 1*, vol. 227, Feb. 1, 1979, p. 785-797. 20 refs. Grant No. NCA2-OR108-801.

The dynamical properties of a prolate bar have been studied by means of a three-dimensional computer model. The bar pattern rotates in the sense of the total angular momentum. The mean particle motion is a rapid streaming in the direction of pattern rotation as seen from a frame that rotates with the bar. Rotation rates that would be inferred from observation are significantly (2-3 times) faster than the pattern rotation speed. Velocity dispersions are anisotropic with the largest component along the bar. Particles oscillate in the bar potential significantly faster than pattern rotation. About 25% of the star orbits are near 2:2:1 resonance with the slow motion along the bar. Particle motion is highly ordered in the bar. Observable properties are described; where comparisons can be made, observable properties are in agreement with observations of brightness contours, velocity fields, and velocity dispersions. The bar has nearly exponential density profiles. (Author)

**A79-23944 \*** The solar latitude and radial dependence of the anomalous cosmic-ray helium component. R. B. McKibben, K. R. Pyle, and J. A. Simpson (Chicago, University, Chicago, Ill.). *Astrophysical Journal, Part 2 - Letters to the Editor*, vol. 227, Feb. 1, 1979, p. L147-L152. 13 refs. NSF Grant No. ATM-77-24494; Contract No. NAS2-6551.

Observations are presented of the spatial intensity gradients of 11-20-MeV per nucleon anomalous helium made with Pioneer 10 and Pioneer 11 over the radial range 1-11.3 AU for Pioneer 10 and to a heliographic latitude of 16 deg at 3.75 AU for Pioneer 11. Evidence is found for a significant gradient in heliographic latitude, with flux increasing away from the equatorial plane at the rate of about 2% to 3% per degree of latitude. This result shows that the common assumption of spherical symmetry for solar modulation is incorrect. By comparison with gradients measured for 29-67-MeV per nucleon helium and for 11-20-MeV and 29-67-MeV protons, it is found that both the radial and latitudinal gradients of the low-energy anomalous helium are the largest of those measured. The implications of these results for the origin of the anomalous component and for solar modulation are briefly discussed. (Author)

**A79-24140 \*** Sealing scientific probes against deep space and the Venusian environment - A tough job. J. Pokras, R. P. Reinert, and R. J. Switz (Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif.). In: Materials synergisms, Proceedings of the Tenth National Technical Conference, Kiamesha Lake, N.Y., October 17-19, 1978. (A79-24076 08-31) Azusa, Calif.: Society for the Advancement of Material and Process Engineering, 1978, p. 860-872. 5 refs. Contract No. NAS2-8300.

The Pioneer Venus mission evolved from studies conducted during the late 1960s and early 1970s. It was found that a need existed for low cost orbiters and landers to explore the planet. The considered mission was to be accomplished with six separate vehicles arriving at Venus nearly simultaneously in mid-December 1978. The probes are designed to survive entry and descent into the atmosphere. A description is presented of the approaches used to maintain sealing integrity for the large and small probes under the constraints imposed by the harsh Venusian environment. Attention is given to probe vehicle configuration, pressure vessel sealing requirements, material and configuration considerations, permanent seals, separable seals, development problems, and aspects of seal testing. G.R.

**A79-24152 \*** Encounter with Venus. L. Colin (NASA, Ames Research Center, Moffett Field, Calif.). *Science*, vol. 203, Feb. 23, 1979, p. 743-745. 8 refs.

The orbiter and multiprobe components of the Pioneer Venus mission are briefly described. The orbiter was launched on May 20, 1978 and was placed into a highly eccentric near-polar orbit around Venus on December 4, 1978, while the multiprobe was launched on August 8, 1978 and reached Venus on December 9, 1978. Parameters of the orbiter orbit are presented, and modifications of the periapsis altitude are described. The time sequences of the probe entry events are reported for the large probe, north probe, day probe, and night probe, which, along with the bus, are the components of the multiprobe. The multiprobe entry and impact locations as well as related data are reported. M.L.

**A79-24153 \*** Initial Pioneer Venus magnetic field results - Dayside observations. C. T. Russell, R. C. Elphic, and J. A. Slavin (California, University, Los Angeles, Calif.). *Science*, vol. 203, Feb. 23, 1979, p. 745-748. 9 refs. Contracts No. NAS2-8088; No. NAS2-9491.

Pioneer Venus magnetometer observations in the sunlit ionosphere indicate that the ionosphere is dynamic and very responsive to external solar wind conditions. Bow shock location, ionosphere location, the strength of the magnetic field just outside the ionopause, and the field strength in the ionosphere are found to be variable, and the properties of flux ropes in the ionospheric magnetic field are considered. Data on magnetic energy density and on magnetic field strength are presented. M.L.

**A79-24155 \*** Initial observations of the Pioneer Venus orbiter solar wind plasma experiment. J. Wolfe, J. Mihalov, H. Collard, D. McKibbin, R. Whitten, A. Barnes (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.), and D. S. Intriligator (Southern California, University, Los Angeles, Calif.). *Science*, vol. 203, Feb. 23, 1979, p. 750-752. 12 refs.

The ionosphere, ionosheath, ionopause, and bow shock wave of Venus are characterized. Venus is found to have a well-defined strong standing bow shock wave. In the ionosheath, downstream from the shock, compressed and heated postshock plasma apparently interacts directly with the ionosphere. Plasma ion velocity deflections suggest that the ionopause has a blunt shape. The positions of the bow shock and ionopause are variable and appear to respond to changes in the external solar wind pressure. M.L.

**A79-24158 \*** Thermal structure and major ion composition of the Venus ionosphere - First RPA results from Venus orbiter. W. C. Knudsen, K. L. Miller (Lockheed Research Laboratories, Palo Alto, Calif.), K. Spenn, V. Novak (Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung, Institut für physikalische Weltraumforschung, Freiburg im Breisgau, West Germany), R. C. Whitten (NASA, Ames Research Center, Moffett Field, Calif.), and J. R. Spreiter (Stanford University, Stanford, Calif.). *Science*, vol. 203, Feb. 23, 1979, p. 757, 758, 763. 9 refs. Bundesministerium für Forschung und Technologie Contract No. 01-Do-238/RV14-B-28/73; Contract No. NAS2-9481.

Pioneer Venus in situ measurements of thermal plasma quantities were obtained by a retarding potential analyzer. Evidence for significant solar wind heating of the ionosphere and indications that the ionosphere is close to diffusive equilibrium are reported. Information on ionopause height, the ionospheric particle pressures at the ionopause, and the measured ratio of ionospheric scale height to ionopause ratio is presented. M.L.

**A79-24161 \*** Venus thermosphere - In situ composition measurements, the temperature profile, and the homopause altitude. U. von Zahn (Bonn, Universität, Bonn, West Germany), D. Krankowsky (Max-Planck-Institut für Kernphysik, Heidelberg, West Germany), K. Mauersberger, A. O. Nier (Minnesota, University, Minneapolis, Minn.), and D. M. Hunten (Arizona, University, Tucson, Ariz.). *Science*, vol. 203, Feb. 23, 1979, p. 768-770. 12 refs. Bundesministerium für Forschung und Technologie Contract No. WRK-275; Contracts No. NAS2-7900; No. NAS2-8812.

The neutral mass spectrometer on board the Pioneer Venus multiprobe bus measured composition and structural parameters of the dayside Venus upper atmosphere on 9 December 1978. Carbon dioxide and helium number densities were  $6 \times 10$  to the 9th and  $5 \times 10$  to the 6th per cubic centimeter, respectively, at an altitude of 150 kilometers. The mixing ratios of the both argon-36 and argon-40 were approximately 80 parts per million at an altitude of 135 kilometers. The exospheric temperature from 160 to 170 kilometers was 285 plus or minus 10 K. The helium homopause was found at an altitude of about 137 kilometers. (Author)

**A79-24164 \*** Venus - Density of upper atmosphere from measurements of drag on Pioneer orbiter. I. I. Shapiro, R. D. Reasenberg (MIT, Cambridge, Mass.), G. R. Hintz, R. A. Jacobson, W. E. Kirchofer, and S. K. Wong (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Science*, vol. 203, Feb. 23, 1979, p. 775-777. 16 refs. Contracts No. NAS7-100; No. NAS2-9483.

Measurements of the changes in orbital period of the Pioneer Venus orbiter are used to estimate the density of the upper atmosphere of Venus at altitudes in the range from 150 to 200 km. At 150 km, the dayside mean density is 1.4 times 10 to the 13th g/cc and the nightside mean density is 4 times 10 to the 14th g/cc. The oscillatory patterns of density variation are described. The data for densities between 150 and 200 km on the dayside are sketchy but the data imply a scale height between 15 and 20 km. M.L.

**A79-24165 \*** Ultraviolet spectroscopy of Venus - Initial results from the Pioneer Venus orbiter. A. I. Stewart, L. W. Esposito, C. A. Barth (Colorado University, Boulder, Colo.), and D. E. Anderson, Jr. (U.S. Navy, Naval Research Laboratory, Washington, D.C.). *Science*, vol. 203, Feb. 23, 1979, p. 777-779. 14 refs. Contracts No. NAS2-8816; No. NAS2-9477.

Ultraviolet spectroscopy of the Venus cloud tops reveals absorption features attributed to sulfur dioxide in the atmosphere above the cloud tops. Measurements of scattered sunlight at 2663 angstroms show evidence for horizontal and vertical inhomogeneities in cloud structure. Images of the planet at SO<sub>2</sub> absorption wavelengths show albedo features similar to those seen at 3650 angstroms from Mariner 10. Airglow emissions are consistent with an exospheric temperature of about 275 K, and a night airglow emission has been detected, indicating the precipitation of energy into the dark thermosphere. (Author)

**A79-24168 \*** Infrared image of Venus at the time of Pioneer Venus probe encounter. J. Apt and R. Goody (Harvard University, Cambridge, Mass.). *Science*, vol. 203, Feb. 23, 1979, p. 785-787. 7 refs. Contract No. NAS2-9127.

An image of the infrared emission from the Earth-facing hemisphere of Venus was obtained at the time the Pioneer Venus probes penetrated the atmosphere. The thermal structure of the atmosphere at the 85-millibar level included regions of rapidly varying polar features, a solar-related postdawn warm area, and a nonsolar-fixed nighttime warm area. The probes succeeded in entering each of these three thermal regions. (Author)

**A79-24169 \*** Structure of the atmosphere of Venus up to 110 kilometers - Preliminary results from the four Pioneer Venus entry probes. A. Seiff, D. B. Kirk, S. C. Sommer, R. E. Young, J. E. Lepetich, P. F. Intrieri (NASA, Ames Research Center, Moffett Field, Calif.), R. C. Blanchard (NASA, Langley Research Center, Hampton, Va.), D. W. Juergens (Ball Aerospace Systems Western Laboratories, Gardena, Calif.), J. T. Findlay (Analytical Mechanics Associates, Inc., Hampton, Va.), and J. S. Derr (U.S. Geological Survey, National Earthquake Information Service, Denver, Colo.). *Science*, vol. 203, Feb. 23, 1979, p. 787-790. 21 refs.

Each of the four Pioneer Venus probes carried instruments to measure the structure of the atmosphere, both below the cloud deck and above it to an altitude of at least 120 km. Preliminary results are presented on lower-atmosphere structure, thermal contrasts, and atmospheric stability. Altitudes derived from the data are given along with the temperature profile from 67 to 105 km, derived from the first analysis of the entry data from the north probe. All four probes lost temperature data at the 640 K level, which is at an altitude of about 12 to 14 km. Values of temperature and pressure at touchdown are presented in a table. The pressure differences imply terrain elevation differences at the landing sites. Above 40 km, the measured profile moves from near-adiabatic toward the theoretical profile for radiative equilibrium. G.R.

**A79-24173 \*** First results from the large probe infrared radiometer experiment. R. W. Boese, J. B. Pollack, and P. M. Silvagno (NASA, Ames Research Center, Moffett Field, Calif.). *Science*, vol. 203, Feb. 23, 1979, p. 797-800. 13 refs.

During the descent to the surface of Venus, the large probe infrared radiometer measured the net thermal radiative flux in several spectral bandpasses. Preliminary analysis has permitted us to estimate (1) the infrared extinction coefficient profile attributable to aerosols, with respect to their visible profile, in the upper atmosphere of Venus and (2) the water vapor mixing ratio below the clouds. An indication of the composition of a multi-component cloud is seen in the data from the spectral bandpass from 6 to 7 micrometers. (Author)

**A79-24174 \*** Venus lower atmospheric composition - Preliminary results from Pioneer Venus. J. H. Hoffman, R. R. Hodges,

Jr. (Texas University, Richardson, Tex.), M. B. McElroy (Harvard University, Cambridge, Mass.), T. M. Donahue (Michigan University, Ann Arbor, Mich.), and M. Kolpin (Physics International Co., San Leandro, Calif.). *Science*, vol. 203, Feb. 23, 1979, p. 800-802. 13 refs. Contracts No. NAS2-8802; No. NAS2-9485.

Initial examination of data from the neutral mass spectrometer on the Pioneer Venus sounder probe indicates that the abundances of argon-36, argon-38, and neon-20 in the Venus atmosphere are much higher than those of the corresponding gases in Earth's atmosphere, although the abundance of radiogenic argon-40 is apparently similar for both planets. The lower atmosphere of Venus includes significant concentrations of various gaseous sulfur compounds. The inlet leak to the mass spectrometer was temporarily blocked by an apparently liquid component of the Venus clouds during passage through the dense cloud layer. Analysis of gases released during the evaporation of the droplets shows the presence of water vapor to some compound or compounds of sulfur. (Author)

**A79-24176 \*** Pioneer Venus radar mapper experiment. G. H. Pettengill, P. G. Ford (MIT, Cambridge, Mass.), W. E. Brown (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), W. M. Kaula (California University, Los Angeles, Calif.), C. H. Keller (NASA, Ames Research Center, Moffett Field, Calif.), H. Masursky (U.S. Geological Survey, Branch of Astrogeology, Flagstaff, Ariz.), and G. E. McGill (Massachusetts University, Amherst, Mass.). *Science*, vol. 203, Feb. 23, 1979, p. 806-808. NASA-supported research.

Altimetry and radar scattering data for Venus, obtained from 10 of the first 13 orbits of the Pioneer Venus orbiter, have disclosed what appears to be a rift valley having vertical relief of up to 7 kilometers, as well as a neighboring, gently rolling plain. Planetary oblateness appears unlikely to exceed 1/2500 and may be substantially smaller. (Author)

**A79-24185 \*** Near-infrared spectra of the Galilean satellites - Observations and compositional implications. J. B. Pollack, F. C. Witteborn, E. F. Erickson, D. W. Strecker, B. J. Baldwin, and T. E. Bunch (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.). *Icarus*, vol. 36, Dec. 1978, p. 271-303. 55 refs.

Reflectivity spectra of the trailing and leading sides of Io, Europa, Callisto, and Ganymede are analyzed which were obtained at an altitude of 41,000 ft from the Kuiper Airborne Observatory with circular variable filter-wheel spectrometers in the spectral region from 0.7 to 5.5 microns. The data are compared with laboratory spectrum and with synthetic spectra constructed on the basis of simple multiscattering theory. The 2.9-micron feature in Callisto's spectra is attributed primarily to bound water; the fractional amounts of water-ice cover on the trailing and leading sides of Ganymede and on the leading side of Europa are estimated. The bare-ground areas on Ganymede are shown to have reflectivity properties comparable to those of Callisto's surface in the studied spectral region, and the surfaces of both satellites are found to contain significant quantities of bound water. It is suggested that minor but significant amounts of ferrous-bearing material (either ferrous salts or alkali feldspars) can account for the 1.35-micron feature of Io. F.G.M.

**A79-24447 \*** Io - An intense brightening near 5 micrometers. F. C. Witteborn, J. D. Bregman, and J. B. Pollack (NASA, Ames Research Center, Moffett Field, Calif.). *Science*, vol. 203, Feb. 16, 1979, p. 643-646. 23 refs.

Spectrophotometric observations of the Jovian satellite Io on February 20 and 21, 1978, (Universal Time) were made from 1.2 to 5.4 micrometers. Io's brightness at 4.7 to 5.4 micrometers was found to be three to five times greater at an orbital phase angle of 68 deg than at orbital phase angles of 23 deg (5.5 hours before the brightening) and 240 deg (20 hours after the brightening). Since the 5-micrometer albedo of Io is near unity under ordinary conditions, the observed transient phenomenon must have been the result of an emission mechanism. Although several such mechanisms were examined, the actual choice is not clear. (Author)

**A79-24581 \*** An upper limit to far infrared emission from the Crab nebula. P. M. Harvey, H. A. Thronson, Jr. (Steward Observatory, Tucson, Ariz.), and I. Gatley (California Institute of Technology, Pasadena, Calif.). *Astronomical Society of the Pacific, Publications*, vol. 90, Dec. 1978-Jan. 1979, p. 655, 656. 15 refs. Grant No. NGR-03-002-390.

Upper limits to the 50- and 100-micron emission from the Crab nebula are reported. These data are consistent with a spectrum that follows a power-law interpolation between the millimeter and near-infrared fluxes. The data are interpreted in terms of an upper limit to thermal emission by dust in the nebula. The upper limit to the amount of dust present is consistent with previously reported upper limits to optical extinction associated with the nebula. (Author)

**A79-24759 \*** Numerical solution of compressible viscous flows. R. W. MacCormack and H. Lomax (NASA, Ames Research Center, Moffett Field, Calif.). In: *Annual review of fluid mechanics*. Volume 11. (A79-24751 09-34) Palo Alto, Calif., Annual Reviews, Inc., 1979, p. 289-316. 48 refs.

The presented review is concerned with the problem of calculating compressible viscous flows. Basic numerical considerations and problems associated with calculating viscous flows are examined and current numerical approaches toward the solution of the Navier-Stokes equations are discussed. It is pointed out that the numerical solution of the full time-dependent equations for turbulent flow is not practical with present computers. Therefore, turbulence effects must be accounted for by modeling. Developments related to turbulence modeling are described. In connection with a discussion of numerical methods for solving viscous flow equations, attention is given to numerical domains of dependence of typical explicit and implicit methods, the diffusion problem, the convection-diffusion problem, and the split-hybrid method. G.R.

**A79-25085 \*** Clean source of metallic Zr for ultrahigh vacuum surface studies. P. R. Davis and H. R. Poppe (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Vacuum Science and Technology*, vol. 15, Sept.-Oct. 1978, p. 1771, 1772. Contract No. NAS2-9629.

**A79-25094 \*** Melting of Io by tidal dissipation. S. J. Peale (California, University, Santa Barbara, Calif.), P. Cassen, and R. T. Reynolds (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). *Science*, vol. 203, Mar. 2, 1979, p. 892-894. 15 refs. Grants No. NGR-05-010-062; No. NCA2-OR680-701.

The resonant structure of Io leads to forced eccentricities that are considerably larger than the free values. Although still modest by all standards, these forced eccentricities coupled with the enormous tides induced by Jupiter lead to magnitudes of tidal dissipation that are large enough to completely dominate the thermal history of Io. In the present paper, the forced eccentricities are calculated and then substituted into an expression for the total tidal dissipation. The results point to the possibility that the dissipation of tidal energy in Io may have melted a major fraction of Io's mass. V.P.

**A79-25104 \*** Rate equation for desorbing particles. T. Halicioglu (NASA/Stanford, Joint Institute for Surface and Microstructural Research, Moffett Field, Calif.). *Journal of Vacuum Science and Technology*, vol. 16, Jan.-Feb. 1979, p. 54-57. 14 refs.

A rate equation describing the desorption of particles from substrates has been formulated using a simple classical model in terms of the particulate escape probabilities and escape velocities. Numerical results for desorption rates as a function of temperature using simple two-body potentials are calculated for various metallic systems. These results were obtained for the low coverage limits and are found to be in good agreement with experimental findings. The present formulation also provides an improved picture of the physical nature of the commonly discussed parameters, such as the frequency factor, desorption energy, and desorption temperature in relation to observed desorption phenomena. (Author)

**A79-25350 \*** Thermal response of composite panels. D. A. Kourtides, W. J. Gilwee, Jr., and J. A. Parker (NASA, Ames Research Center, Moffett Field, Calif.). *Polymer Engineering and Science*, vol. 19, no. 3, Feb. 1979, p. 226-231. 10 refs.

The thermochemical and flammability characteristics of laminating resins and composites currently in use and others being considered for use as aircraft interior panels are described. The properties studied included: (1) limiting oxygen index of the composite constituents; (2) fire containment capability of the composite; (3) smoke evolution from the composite; (4) thermogravimetric analysis; (5) composition of the volatile products of thermal degradation; and (6) relative toxicity of the volatile products of pyrolysis. The performance of high-temperature laminating resins such as modified phenolics, polyimides and bismaleimides is compared with the performance of epoxies. The relationship of increased fire safety with the use of polymers with high anaerobic char yield is shown. Processing parameters of the state-of-the-art epoxy resin and the advanced resin composites are detailed.

(Author)

**A79-25355 \*** Latitudinal variations of stratospheric aerosols. N. H. Farlow, G. V. Ferry (NASA, Ames Research Center, Moffett Field, Calif.), H. Y. Lem, and D. M. Hayes (LFE Corp., Richmond, Calif.). *Journal of Geophysical Research*, vol. 84, Feb. 20, 1979, p. 733-743. 23 refs.

We have obtained stratospheric aerosols from tropical to northern latitudes using special collectors on U-2 aircraft during 1976 and 1977. Aerosols characterized by large numbers of small particles are found in the tropical zone suggesting this is a region of particle growth; whereas aerosols containing mostly larger particles are distributed throughout the Northern Hemisphere indicating a well-mixed, mature population. We find the aerosol layer extends from higher altitudes near the equator to lower ones toward the pole. Although this gradient suggests mature aerosols may leave the stratosphere at high latitudes, the data are, as yet, inconclusive. Comparisons of our data with those of other investigators using different instruments are generally encouraging, suggesting that if similar populations were sampled, the results would be similar. When our calculated sulfate mass mixing ratios are compared with those measured directly by others, we find better agreement is achieved if we assume more dilute sulfate and water mixtures than previously proposed.

(Author)

**A79-25852 \*** Space reflector technology and its system implications. K. W. Billman, W. P. Gilbreath (NASA, Ames Research Center, Moffett Field, Calif.), and S. W. Bowen (Beam Engineering, Inc., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 15th, Washington, D.C., Feb. 6-8, 1979, Paper 79-0545*. 18 p. 18 refs.

The technical feasibility of providing nearly continuous solar energy to a world-distributed set of conversion sites by means of a system of orbiting, large-area, low-area-density reflecting structures is examined. Requisite mirror area to provide a chosen, year-averaged site intensity is shown. A modeled reflector structure, with suitable planarity and ability to meet operational torques and loads, is discussed. Typical spatial and temporal insolation profiles are presented. These determine the sizing of components and the output electric power from a baselined photovoltaic conversion system. Technical and economic challenges which, if met, would allow the system to provide a large fraction of future world energy needs at costs competitive to circa-1995 fossil and nuclear sources are discussed.

(Author)

**A79-26041 \*** On the internal structure of the major satellites of the outer planets. R. T. Reynolds and P. M. Cassen (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). *Geophysical Research Letters*, vol. 6, Feb. 1979, p. 121-124. 21 refs.

The structures and thermal evolutions of the large icy-satellites of the outer solar system are considered. It is shown (for bodies

comparable in size and mass to the Galilean satellites, having sizeable mass fraction of H<sub>2</sub>O, and with meteoritic abundances of radioactive materials contained within their silicate fractions) that the crust of solid ice over a liquid mantle predicted by conductive heat-transfer calculations is unstable to large-scale solid-state convection. For appropriate material parameters, convective heat-transfer rates are sufficient to freeze a large liquid mantle on a time scale that is short compared to the lifetime of the body. It is also concluded that the ice layer is convecting at the present time. A reevaluation of previous work, using improved values for material parameters and boundary conditions, reverses earlier conclusions and implies a rigid outer crust with resulting long-term stability of surface features to creep deformation. The combination of a rigid crust with active internal convection presents the additional possibility of surface features that are produced and maintained by dynamic internal processes. (Author)

**A79-26134 \*** Opacified silica reusable surface insulation /RSI/ for thermal protection of the Space Shuttle Orbiter. H. E. Goldstein, M. Smith, D. Stewart (NASA, Ames Research Center, Moffett Field, Calif.), and D. B. Leiser (NASA, Ames Research Center, Moffett Field; Stanford University, Stanford, Calif.). In: Thermal conductivity. New York, Plenum Publishing Corp., 1978, p. 335-341.

The present paper deals with a second-generation reusable surface insulation (RSI) material, termed LI-2200, which has been chosen for use on limited areas of the Orbiter heat shield. It is a rigid sintered fibrous silica containing about 3% by weight 1200 grit silicon carbide powder, capable of surviving multiple reentries at temperatures on the order of 1400 C. The lower thermal conductivity achieved by opacification with silicon carbide is demonstrated by radiant transmission measurements and thermal response tests.

V.P.

**A79-26145 \*** The use of hybrid integrated circuit techniques in biotelemetry applications. T. B. Fryer (NASA, Ames Research Center, Moffett Field, Calif.). *Biotelemetry*, vol. 4, no. 4, 1977, p. 193-216. 9 refs.

A review is presented of some features of hybrid integrated circuits that make their use advantageous in miniature biotelemetry applications. The various techniques for fabricating resistors, capacitors and interconnections by both thin film and thick film technology are discussed. The use of chip capacitors, resistors, and especially standard IC chips on substrates with fired-on interconnection patterns is emphasized. The review is designed primarily to acquaint biotelemetry users and designers with an overview of this fabrication technique so that they can better communicate their needs with an understanding of its limitations and advantages to facilities specializing in hybrid construction. (Author)

**A79-26248 \*** A comparison of theoretical and experimental video compression designs. H. W. Jones, Jr. (COM-CODE, Inc., Mountain View, Calif.). *IEEE Transactions on Electromagnetic Compatibility*, vol. EMC-21, Feb. 1979, p. 50-56. 25 refs. Contract No. NAS2-9703.

This paper compares theoretical and experimental picture compression designs, for images processed in 8 x 8 blocks using the Walsh-Hadamard transform (WHT). The optimum picture compression design is well known, if the mean-square error (mse) is used as the measure of distortion, and if it is assumed that the video process is a stationary first-order Markov process with a Gaussian distribution. This theoretical design gives useful results when the transform processing is done on full pictures, but gives inferior results (relative to empirical design) when transform processing is done on small 8 x 8 blocks. The use of non-Gaussian distributions for the transform components fails to improve this poor performance, which is due to the nonstationary nature of the video process. An experimentally based design procedure, which considers nonstationarity, yields significantly improved mse and subjective performance. (Author)

**A79-26581 \*** Effect of pyrolysis temperature and air flow on toxicity of gases from a polystyrene polymer. C. J. Hilado, E. M. Olcomendy, and D. P. Brauer (San Francisco, University, San Francisco, Calif.). *Journal of Combustion Toxicology*, vol. 6, Feb. 1979, p. 13-19. 6 refs. Grant No. NsG-2039.

**A79-26582 \*** Toxicity of pyrolysis gases from polyoxymethylene. C. J. Hilado, J. E. Schneider, and D. P. Brauer (San Francisco, University, San Francisco, Calif.). *Journal of Combustion Toxicology*, vol. 6, Feb. 1979, p. 30-36. Grant No. NsG-2039.

A sample of polyoxymethylene was evaluated for toxicity of pyrolysis gases, using the toxicity screening test method developed at the University of San Francisco. Under several test conditions, this material gave shorter times to death than many other synthetic polymers. Carbon monoxide appeared to be the principal toxicant in the pyrolysis gases. (Author)

**A79-26583 \*** Effect of pyrolysis temperature and air flow on toxicity of gases from Douglas fir in USF toxicity test. C. J. Hilado, E. M. Olcomendy, and D. P. Brauer (San Francisco, University, San Francisco, Calif.). *Journal of Combustion Toxicology*, vol. 6, Feb. 1979, p. 48-57. 7 refs. Grant No. NsG-2039.

**A79-26584 \*** Weight control and restraint of laboratory rats. C. J. Hilado and K. Van Breda Kolff (San Francisco, University, San Francisco, Calif.). *Journal of Combustion Toxicology*, vol. 6, Feb. 1979, p. 58-62. 14 refs. Grant No. NsG-2039.

The use of restrained and confined rats in some procedures used in combustion toxicology introduces the problems of obtaining rats of the appropriate size for the apparatus, and of identifying any artifacts resulting from the use of restraint alone. Feeding studies indicate that controlled feeding of fast-growing strains such as the Sprague-Dawley can hold rat size essentially constant for significant periods of time. The undesirable aspects are the need to cage the animals individually, with resultant psychological as well as metabolic effects. Restraint studies of slow-growing strains such as the Fischer 344 indicate that denying access to food and water for periods of several hours at a time interrupts normal gain only temporarily. (Author)

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**A79-26595 \*** Radiation energy conversion in space. K. W. Billman (NASA, Ames Research Center, Materials and Physical Sciences Branch, Moffet Field, Calif.). *Astronautics and Aeronautics*, vol. 17, Mar. 1979, p. 18-26.

Topics discussed at the third NASA conference on radiant energy conversion are reviewed. The unconcentrated-photovoltaic-generation version of a solar power satellite is described, noting that it will consist of a 21.3 x 5.3 sq-km silicon-solar-cell array expected to provide 17 Gw of electrical power, with 1 km in diam transmitters oriented to beam 2.45 GHz microwave power to two receiving/rectifying 'rectennas' on earth. The Solares space-energy-system concept, designed for providing a large fraction of the world's energy needs at costs comparable to those of future coal/nuclear alternative, is considered, as are subsystems for improving the economics of the solar power satellite. A concept proposing the use of relativistic-electron-storage rings for electron-beam energy transmission and storage, and a report on the production of a high temperature plasma with concentrated solar radiation are taken into account. Laser-conversion systems, including the direct-solar-pumped space laser, and the telec-powered spacecraft, are discussed. A.A.

**A79-26687 \*** High-angular-resolution far-infrared observations of the Rho Ophiuchi dark cloud. P. M. Harvey, M. F. Campbell, and W. F. Hoffmann (Steward Observatory, Tucson, Ariz.). *Astrophysical Journal, Part 1*, vol. 228, Mar. 1, 1979, p. 445-449. 21 refs. Grant No. NGR-03-002-390.

**A79-26792 \*** Numerical calculations of protostellar hydrodynamic collapse. P. Bodenheimer (Lick Observatory, Santa Cruz, Calif.) and D. C. Black (NASA, Ames Research Center, Moffett Field, Calif.). In: Protostars and planets: Studies of star formation and of the origin of the solar system. (A79-26776 10-90) Tucson, Ariz., University of Arizona Press, 1978, p. 288-322. 66 refs. NASA-supported research.

Although 1-D (spherically symmetric) experiments of protostar collapse are highly idealized, they are the only ones which have been carried to a stage where a 'stellar' object is formed. Experiments have shown that the parameters (e.g., radius and luminosity) of the visible stellar core are sensitive to the assumed initial conditions, particularly the initial density. One of the major findings of 2-D numerical experiments is the formation of rings. Three-dimensional hydrodynamical calculations indicate that a collapsing cloud will break up into two or more orbiting subcondensations with the possible subsequent development of a stellar multiple system. G.R.

**A79-26934 \* #** Wind-tunnel fan noise reduction including effects of turning vanes on noise propagation. P. T. Soderman (NASA, Ames Research Center; U.S. Army, Research and Technology Laboratories, Moffett Field, Calif.) and L. E. Hoglund (Beam Engineering, Inc., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 5th, Seattle, Wash., Mar. 12-14, 1979, Paper 79-0642.* 7 p. 10 refs.

Fan silencers with low-pressure drop have been designed and installed in the NASA Ames 7- by 10-Foot Wind Tunnel No. 1. The silencers are composed of an absorbent lining flush with the wind-tunnel walls upstream of the fan and an absorbent splitter in the duct downstream of the fan. An acoustical insertion loss of 4 to 12 dB was measured between 100 and 1000 Hz. High-frequency performance of the silencers was reduced by test-section noise and by corner vanes which turned the sound waves so they followed the duct axis. Sound below 1.2 kHz diffracted around the 305-mm-long vanes and impinged on acoustically absorbent corner walls. Wind-tunnel flow losses are discussed. (Author)

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**A79-27131 \*** Bistatic synthetic aperture radar using two satellites. K. Tomiyasu (GE Valley Forge Space Center, Philadelphia, Pa.). In: EASCON '78: Electronics and Aerospace Systems Convention, Arlington, Va., September 25-27, 1978, Record. (A79-27126 10-32) New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 106-110. 8 refs. Contract No. NAS2-9580.

The paper demonstrates the feasibility of a bistatic synthetic aperture radar (BISAR) utilizing two satellites. The proposed BISAR assumes that the direction of the two narrow antenna beams are programmed to coincide over the desired area to be imaged. Functionally, the transmitter and receiver portions can be interchanged between the two satellites. The two satellites may be in one orbit plane or two different orbits such as geosynchronous and low-earth orbits. The pulse repetition frequency and imaging geometry are constrained by contours of isodops and isodels. With two images of the same area viewed from different angles, it is possible in principle to derive three-dimensional stereo images. Applications of BISAR include topography, water resource management, and soil moisture determination. Advantages of BISAR over a monostatic SAR are mentioned, including lower transmitter power and greater ranges in incidence angle and coverage. S.D.

**A79-27192 \*** Error analysis of finite difference schemes applied to hyperbolic initial boundary value problems. G. Skoikermo (Uppsala, Universitet, Uppsala, Sweden). *Mathematics of Computation*, vol. 33, Jan. 1979, p. 11-35. 7 refs. Research sponsored by the Swedish Institute for Applied Mathematics; Grant No. NCA2-OR745-702.

Finite difference methods for the numerical solution of mixed initial boundary value problems for hyperbolic equations are studied. The reported investigation has the objective to develop a technique for the total error analysis of a finite difference scheme, taking into account initial approximations, boundary conditions, and interior approximation. Attention is given to the Cauchy problem and the initial approximation, the homogeneous problem in an infinite strip with inhomogeneous boundary data, the reflection of errors in the

boundaries, and two different boundary approximations for the leapfrog scheme with a fourth order accurate difference operator in space. G.R.

**A79-27373 \*** An atomistic calculation of two-dimensional diffusion of a Pt adatom on a Pt(110) surface. T. Halicioglu (NASA, Ames Research Center, Moffett Field, Calif.). *Surface Science*, vol. 79, no. 1, Jan. 1979, p. L346-L348.

Results of an atomistic calculation supporting two-dimensional diffusion of a Pt atom on a Pt(110) surface are presented. The calculations for diffusion energies indicate that interchannel diffusion by the replacement of a channel-wall atom by the adatom is energetically favorable. A.A.

**A79-27425 \*** C-13 NMR spectroscopic study of epoxidized 1,4-polyisoprene and 1,4-polybutadiene. R. V. Gemmer and M. A. Golub (NASA, Ames Research Center, Moffett Field, Calif.). (*American Chemical Society, Western Regional Meeting, Anaheim, Calif., Oct. 12-14, 1977.*) *Journal of Polymer Science, Part A - Polymer Chemistry*, vol. 16, 1978, p. 2985-2990. 15 refs.

**A79-27695 \*** Cool stars - Effective temperatures, angular diameters, and reddening determined from 1.5 micron flux curves and model atmospheres. J. D. Scargle and D. W. Strecker (NASA, Ames Research Center, Space Science Div., Moffett Field, Calif.). *Astrophysical Journal, Part 1*, vol. 228, Mar. 15, 1979, p. 838-853. 48 refs.

**A79-27712 \*** Jovian electron propagation out of the solar equatorial plane - Pioneer 11 observations. D. C. Hamilton and J. A. Simpson (Chicago, University, Chicago, Ill.). *Astrophysical Journal, Part 2 - Letters to the Editor*, vol. 228, Mar. 15, 1979, p. L123-L127. 17 refs. NSF Grant No. ATM-77-24494; Contract No. NAS2-6551.

Jovian electron intensity in the energy range 2-7 MeV was measured along the trajectory of Pioneer 11 up to 16 deg heliographic latitude. These electrons have crossed the average direction of the interplanetary magnetic field, propagating normal to the solar equatorial plane, and their intensity continues to be modulated by corotating interaction regions over this latitude range. From these data, the electron diffusion coefficient perpendicular to the equatorial plane ( $K_2 = 2 \times 10$  to the 20th sq cm/s) was derived to within a factor 2 using a three-dimensional diffusion-convection model and the values of the parallel and perpendicular diffusion coefficients in the solar equatorial plane ( $K_y = 5 \times 10$  to the 22nd sq cm/s,  $K_z = 10$  to the 21st sq cm/s, respectively), which had previously successfully described Jovian electron propagation near the equatorial plane from 1 to about 10 AU. These results indicate that the Jovian electron intensity may be very low at high solar latitudes. (Author)

**A79-27857 \*** Simulated lidar return from a one-dimensional stratospheric aerosol model. P. Hamill, T. J. Swissler (Systems and Applied Sciences Corp., Hampton, Va.), R. P. Turco (R & D Associates, Inc., Marina del Rey, Calif.), and O. B. Toon (NASA, Ames Research Center, Moffett Field, Calif.). *Nature*, vol. 278, Mar. 8, 1979, p. 149-152. 13 refs. Contracts No. NAS1-15077; No. NAS2-9881.

Results are presented for theoretical calculations of lidar backscatter at wavelengths of 0.6943 and 1.06 microns from the stratospheric aerosol. The computations are based on the size distribution, particle number density, and particle composition predicted by a one-dimensional model of the stratospheric aerosol layer that assumes that the primary source of sulfur to the stratosphere is biogenic OCS released at ground level. The aerosol particles are taken to be spherical liquid H<sub>2</sub>SO<sub>4</sub>-H<sub>2</sub>O solution droplets with solid cores, which undergo condensation, evaporation, coagulation, sedimentation, and vertical eddy mixing. The theoretical backscatter profiles are compared with experimental results obtained from actual lidar observations of the stratospheric aerosol layer before and after the eruption of Volcán de Fuego in October 1974. The model predictions are shown to be in good agreement with the average of a number of observations. F.G.M.

**A79-28005 \*** Hadamard techniques in optics and their relationship to other multiplexing schemes. M. Harwit (Cornell University, Ithaca, N.Y.). In: Computers in optical systems; Proceedings of the Seminar, San Diego, Calif., August 28, 29, 1978. (A79-28001 10-59) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 119-122. 17 refs. Grant No. NGR-33-010-146.

Some general properties of multiplexing optical systems for astronomical applications are described. The advantages and disadvantages which characterize Fourier and digitally encoded instruments when faced with any of ten sources of noise are discussed.

B.J.

**A79-28017 \*** Comparison of video fields and frames for transform compression. H. W. Jones, Jr. (COM-CODE, Inc., Mountain View, Calif.) and L. B. Hofman (NASA, Ames Research Center, Moffett Field, Calif.). In: Applications of digital image processing; Proceedings of the Seminar, San Diego, Calif., August 28, 29, 1978. (A79-28006 10-35) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 214-221. 7 refs. Contract No. NAS2-9703.

Because of the interlaced television scan, the two fields that form an interlaced video frame are generated 1/60 of a second apart. If the two fields are compressed independently, the correlation between adjacent lines is unused. The transmission rate can be reduced by using a field memory to form an interlaced frame. Four test images were processed as fields and as interlaced frames, using both theoretical and experimental compression designs. For comparable mean-square error and subjective appearance, field compression requires about one-half bit per sample more than frame compression. However, the overall transmission rate - the number of bits per image times the number of images per second - is more meaningful than the number of bits per sample. When transform compression at low transmission rates merges the adjacent lines, frame compression becomes similar to field repeating, and the memory can be reduced. (Author)

**A79-28129 \*** Overview of laser applications to chemistry. T. F. George (Rochester, University, Rochester, N.Y.). In: Laser spectroscopy - Applications and techniques; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978. (A79-28128 10-25) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 2-10. 43 refs. NSF Grants No. CHE-77-14548; No. CHE-77-27826; Contract No. F49620-78-C-0005; Grant No. NSG-2198.

The discussion is in three parts. First, laser spectroscopy is discussed with consideration given to single-photon and multiphoton processes. Second, attention is given to the use of lasers in studying molecular interactions and reaction dynamics. Finally, the paper discusses the relationship between chemistry and laser development.

B.J.

**A79-28267 \*** Computer analysis of shells of revolution using asymptotic results. C. R. Steele (Shell Technology Associates; Stanford University, Stanford, Calif.), G. V. Ranjan (Shell Technology Associates, Stanford; Failure Analysis Associates, Palo Alto, Calif.), C. Goto (Shell Technology Associates, Stanford, Calif.), and T. H. Pulliam (NASA, Ames Research Center, Mountain View; Shell Technology Associates, Stanford, Calif.). In: Structures, Structural Dynamics, and Materials Conference, 20th, St. Louis, Mo., April 4-6, 1979, Technical Papers on Dynamics and Loads. (A79-28251 10-39) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 162-170. 13 refs. (AIAA 79-0752)

It is suggested that asymptotic results for the behavior of thin shells can be incorporated in a general computer code for the analysis of a complex shell structure. The advantage when compared to existing finite difference or finite element codes is a substantial

reduction in computational labor with the capability of working to a specified level of accuracy. A reduction in user preparation time and dependence on user judgment is also gained, since mesh spacing can be internally generated. The general theory is described in this paper, as well as the implementation in the computer code FAST 1 (Functional Algorithm for Shell Theory) for the analysis of the general axisymmetric shell structure with axisymmetric loading. (Author)

**A79-29001 \*** Scattering of emitted radiation from inhomogeneous and nonisothermal layers. R. W. Bergstrom (Illinois, University, Chicago, Ill.) and A. C. Cogley (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 21, Mar. 1979, p. 279-292. 7 refs. NSF Grant No. ENG-74-17488; Grant No. NCA2-OR330-701.

A parametric study is performed for the exiting monochromatic intensities scattered from finite plane-parallel inhomogeneous layers that are driven solely by a distribution of thermal sources. Intensities are obtained by invariantly imbedding the standard and thermal scattering functions. The single-scattering albedo and the Henyey-Greenstein phase-function parameter are varied independently, and both linear and exponential profiles are considered. Linear temperature profiles are used, including temperature inversions. The resulting intensities, as a function of the direction cosine of propagation, are discussed from a remote-sensing point of view. For an isothermal and homogeneous medium, the gross characteristics of the exiting intensity, represented by its overall slope, mean value (magnitude), and an interior maximum value, can be related to the total optical depth, single-scattering albedo, and phase function, respectively. For a homogeneous medium, linearly decreasing (in the line of sight) temperature profiles tend to obscure the phase-function information and decrease the apparent optical depth. On the other hand, linearly increasing temperature profiles tend to retain phase-function information and increase the apparent optical depth. Temperature inversion profiles give intensities very similar to those for purely linear profiles. (Author)

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**A79-29176 \*** On inhomogeneous scattering models of Titan's atmosphere. M. Podolak (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.; Tel Aviv University, Tel Aviv, Israel) and L. P. Giver (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.). *Icarus*, vol. 37, Feb. 1979, p. 361-376. 36 refs.

Podolak and Danielson (1977) discussed the homogeneous model of Titan's atmosphere with the dust and gas uniformly mixed. They were able to reproduce the equivalent widths of the CH<sub>4</sub> bands at 4680 and 5430 Å but failed to agree with the observations in the near infrared. The present paper develops an inhomogeneous model which has the dust and gas essentially separated; this model agrees fairly well with the near-IR data of Younkin (1974) but does not agree with the data of Lutz et al. (1976) for the 4860-Å band and it must be adjusted to match their data for the 5430-Å band. B.J.

**A79-30248 \*** Fracture modes and acoustic emission of composite materials. A. Rotem and E. Altus (NASA, Ames Research Center, Materials and Physical Sciences Branch, Moffett Field, Calif.; Technion - Israel Institute of Technology, Haifa, Israel). *Journal of Testing and Evaluation*, vol. 7, Jan. 1979, p. 33-40. 9 refs.

Unidirectional fibrous composite material laminae are the construction material of a laminate. Four failure modes can occur in this material, and the identification of these modes is as important as the identification of onset of fracture. Acoustic emission (AE) pulses, generated by the change in the stress field resulting from cracking in a material, have a unique pattern of amplitude distribution that depends only on the mode of fracture and the type of material. By using a tapered double-cantilever beam as grips for the unidirectional lamina, a crack with a constant stress intensity factor was induced, thus eliminating the factor of the stress level. Placing the lamina in different directions relative to the grips imposed a different failure mode. By plotting the log of the relative number of AE pulses above some level versus the log of the relative level, a single constant coefficient can be measured for each material and

mode of fracture. The AE energy is proportional to the energy released by the cracking; this proportionality depends on the medium where the AE waves have to travel, and not on the cracking mode. (Author)

**A79-30473 \*** Modification of solar lines propagating through the interplanetary medium. F. M. Wu and D. L. Judge (Southern California University, Los Angeles, Calif.). *Journal of Geophysical Research*, vci. 84, Mar. 1, 1979, p. 979-982. 10 refs. Contract No. NAS2-6558.

The optical depths of the solar H Lyman-alpha and the He 584-A lines in interplanetary space are calculated. From these the solar line profiles at Saturn and Uranus are determined. It is found that the solar H Lyman-alpha line can be diminished strongly within a spectral region of less than 0.2 Å from the line center. On the other hand, there is no significant absorption of the He 584-A line except in the downwind region, where absorption occurs within a spectral region of about 0.04 Å. The effects of solar line modification on planetary and interplanetary glow observations are discussed. (Author)

**A79-30603 \*** Reynolds number effects on the turbulence field in compressible boundary layers. M. Acharya, C. C. Horstman, and M. I. Kussoy (NASA, Ames Research Center, Moffett Field, Calif.). *AIAA Journal*, vol. 17, Apr. 1979, p. 380-386. 19 refs.

Detailed experiments were conducted in a zero pressure gradient, supersonic turbulent boundary layer, including measurements of the three components of velocity fluctuations and the turbulent shear stress, for Reynolds numbers ranging from 11.7 million to 105 million at a freestream Mach number of 2.3. The mean flow measurements established the fully developed and equilibrium nature of the boundary layer. Measurements of the turbulence field show that the vertical and transverse fluctuations are essentially equal throughout the boundary layer at all Reynolds numbers, a feature that is different from observations in incompressible flows. The data show that the boundary layer exhibits similarity in the turbulence profiles for the entire Reynolds number range and agrees with previous compressible and incompressible data using Morkovin's scaling to account for compressibility effects. (Author)

**A79-31002 \*** Cryogenics for spacecraft. J. W. Vorreiter (NASA, Ames Research Center, Moffett Field, Calif.). In: ICEC 7: Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. (A79-31001 12-31) Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 1-17. 32 refs.

It is pointed out that cryogenic engineering has been an integral part of space research almost from the beginning of the space age because of the significant performance advantages available from cryogenically fueled rocket engines. In recent years, space-related cryogenic engineering has expanded from booster engines to include spacecraft systems because of the vastly improved performance available from cooled detectors and systems. The requirements for detector cooling in space are examined, taking into account earth observation, atmospheric measurements, infrared astronomy, X-ray astronomy, gamma-ray astronomy, radio astronomy, relativity measurements, magnetic field measurements, time measurements, and data processing. A description is presented of 1978-1981 U.S. spacecraft cryogenic detector systems. G.R.

**A79-31013 \*** Design of a superfluid helium dewar for the IRAS telescope. A. R. Urbach (Ball Corp., Ball Aerospace Systems, Boulder, Colo.), J. Vorreiter (NASA, Ames Research Center, Moffett Field, Calif.), and P. Mason (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: ICEC 7: Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. (A79-31001 12-31) Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 126-133. Contract No. NAS2-9700.

The Infrared Astronomy Satellite (IRAS) is planned for launch in 1981, and is a joint project of the Netherlands, the United Kingdom and the United States. The instrument will consist of a superfluid helium-cooled 60 cm telescope with a large array of

infrared detectors at the focal plane. The primary purpose of the mission is to perform an all-sky survey in the infrared region from 8 to 120 micrometers. The dewar contains 70 kg of superfluid helium which will maintain the telescope and detectors at 2 K for one year. The dewar contains a supercritical helium cover tank which will be ejected after the experiment has been in orbit for two weeks. (Author)

**A79-31218 \*** A liquid-helium-cooled grating spectrometer for far infrared astronomical observations. J. R. Houck and D. Ward (Cornell University, Ithaca, N.Y.). *Astronomical Society of the Pacific, Publications*, vol. 91, Feb.-Mar. 1979, p. 140-142. 12 refs. Grants No. NGR-33-010-146; No. NGR-33-010-182.

A liquid-helium-cooled grating spectrometer has been developed for low-resolution far-infrared spectrometric measurements of astronomical sources conducted by the 30-cm NASA Lear Jet telescope. Simple MOSFET coupled transimpedance preamplifiers were adopted for the spectrometer design. The infrared spectrometer has resolving powers from 10 to 150 over the wavelength range from 45 to 115 microns. J.M.B.

**A79-31219 \*** A far-infrared photometer for the Kuiper Airborne Observatory. P. M. Harvey (Steward Observatory, Tucson, Ariz.). *Astronomical Society of the Pacific, Publications*, vol. 91, Feb.-Mar. 1979, p. 143-148. 8 refs. Grant No. NGR-03-002-390.

A high-angular-resolution multiaperture far-IR photometric instrument for multicolor observations of a variety of objects at effective wavelengths of 40 to 160 microns is described which is ideal for use on NASA's Kuiper Airborne Observatory. The operational principles of the instrument are discussed, along with the far-IR radiometer and the offset guiding module. System performance is evaluated on the basis of the noise-equivalent flux of the radiometer, guiding accuracy capability, the suitability to the scientific objectives of the filter bandpasses and focal-plane aperture sizes, the ease of operation, and operating efficiency. Some examples of recent observations with this instrument are provided. F.G.M.

**A79-31514 \*** Climatic change on the terrestrial planets. J. B. Pollack (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.). *Icarus*, vol. 37, Mar. 1979, p. 479-553. 120 refs.

Observational data related to climatic change on Venus, earth and Mars are reviewed. The channel features on Mars suggest an early to intermediate epoch of warmer and wetter climate, while the layered polar deposits imply more recent periodic variations in climate. A more reducing atmosphere, which would have produced an enhanced greenhouse effect, may have been responsible for warmer periods in the early history of Mars and earth. Detailed calculations relating atmospheric pressure and composition to the temperature state of Mars are presented. The possibility of a runaway greenhouse effect on Venus resulting in the emplacement of volatiles entirely in the atmosphere is also examined. Periodic variations in orbital eccentricity and axial obliquity may have contributed to alternating glacial and interglacial periods on earth. Mechanisms accounting for the laminated terrain of Mars, and the influence of Martian tectonic distortions on the planet's climate also receive attention. J.M.B.

**A79-31518 \*** Gas drag in primordial circumplanetary envelopes - A mechanism for satellite capture. J. B. Pollack, M. E. Tauber (NASA, Ames Research Center, Moffett Field, Calif.), and J. A. Burns (Cornell University, Ithaca, N.Y.). *Icarus*, vol. 37, Mar. 1979, p. 587-611. 53 refs. Grant No. NCA2-OR175-701.

Known properties of the current solar system and Bodenheimer's (1977) model of early Jovian evolution are employed to develop a mechanism for satellite capture based on gas drag in primordial circumplanetary envelopes. In particular, the deceleration and fragmentation of two parent bodies passing through an extended primordial Jovian nebula may account for the clusters of prograde and retrograde satellites of Jupiter. Subsequently, the fragments probably underwent limited orbital evolution, and were dispersed by collision with a stray body. The heavy element cores of the outer planets may also be due to primordial gas drag capture. Nebular drag capture of the Martian satellites Phobos and Deimos, Neptune's

Nereid and Triton, and Saturn's Phoebe and Iapetus is also conceivable.

J.M.B.

A79-32120 \* Shock-tube determination of absorption cross sections and A 2 Delta - X 2 Pi band transition moments of SiH. C. Park (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 21, Apr. 1979, p. 373-385. 17 refs.

A79-32207 \* Spatially resolved methane band photometry of Jupiter. I - Absolute reflectivity and center-to-limb variations in the 6190-, 7250-, and 8900-A bands. II - Analysis of the south equatorial belt and south tropical zone reflectivity. R. A. West (Arizona, University, Tucson, Ariz.). *Icarus*, vol. 38, Apr. 1979, p. 12-53. 49 refs. NSF Grant No. AST-76-06809; Contracts No. JPL-954057; No. NAS2-6265.

Spatially resolved measurements of the absolute reflectivity and center to limb variations of Jupiter in the 6190, 7250 and 8900 Å methane bands and nearby continuum regions are presented and analyzed for the south equatorial belts (SEBs) and south tropical zone (STrZ). It is found that the polar hoods, equatorial zone, Red Spot and north tropical zone have highest methane reflectivities, with the temperate zones and polar regions having low reflectivity and the STrZ and SEBs having intermediate values. The data on the SEB and STrZ are analyzed in terms of diffuse reflecting-scattering and two-cloud models of the vertical distribution of aerosols in the Jovian atmosphere. To fit observations, the STrZ cloud top must have between 0.55 and 0.43 bar total pressure and optical depth between 1.5 and 2.5. The reflecting-scattering models are not suitable for the SEBs. The SEB upper cloud is deeper, cloud thickness is less and the lower cloud is deeper than in the STrZ. A forward scattering haze layer accounts for limb darkening in the continuum.

A.L.W.

A79-32208 \* The vertical structure and thickness of Saturn's rings. J. N. Cuzzi (NASA, Ames Research Center, Moffett Field, Calif.), R. H. Durisen (NASA, Ames Research Center, Moffett Field, Calif.; Indiana University, Bloomington, Ind.), J. A. Burns, and P. Hamill (NASA, Ames Research Center, Moffett Field, Calif.; Cornell University, Ithaca, N.Y.). *Icarus*, vol. 38, Apr. 1979, p. 54-68. 17 refs. Grants No. NCA2-OR175-701; No. NSG-2227.

The steady state thickness and vertical structure of Saturn's rings are discussed with regard to whether a collapse to a monolayer due to particle collisions may be prevented by various mechanisms. The differences between thick rings and wavy monolayers are outlined and used to show that such coherent perturbations to the rings as satellite and solar gravitational effects would produce a wavy monolayer while such dispersive mechanisms as meteoroid impact, radiation pressure, Kepler shear and radial spreading, which would produce the random particle motions necessary to maintain a thick layer, are probably insignificant. Given a typical power law distribution of particle sizes, it is found that gravitational scattering of small particles by large ones would maintain a ring thickness of several times the radius of the largest particles. A steady state ring thickness of 20 to 50 meters, derived from energy considerations, would imply a maximum particle size of a few meters.

A.L.W.

A79-32217 \* Searching for nonsoiular planets. R. N. Bracewell (Stanford University, Stanford, Calif.) and R. H. MacPhie (Waterloo, University, Waterloo, Ontario, Canada). *Icarus*, vol. 38, Apr. 1979, p. 136-147. 19 refs. Grant No. NCA2-OR745-716.

The use of infrared techniques to search for nonsoiular planets is examined and compared with other possible methods. Long focus astrometry, spectroscopic radial velocity measurements and space-borne apodization all use visible light and need further refinement to be practical. Infrared offers an advantage of about 10 to the 5th over visible light as regards the ratio of power received from star and planet. Long baseline infrared interferometry from earth orbit could place an interferometric null on the star to enhance planetary radiation and a spinning interferometer would modulate planetary emission to permit synchronous detection; such an interferometer is illustrated. The limit to sensitivity would be set by thermal radiation to the detector and the infrared component of zodiacal light. A.L.W.

A79-32650 \* Thermochemical and flammability properties of some thermoplastic and thermoset polymers - A review. D. A. Kourtides (NASA, Ames Research Center, Moffett Field, Calif.). *Polymer-Plastics Technology and Engineering*, vol. 11, no. 2, 1978, p. 159-198. 46 refs.

The thermochemical and flammability properties of thermoplastic and thermoset polymers are discussed. The results of a thermogravimetric analysis of the polymers conducted on a DuPont 950 thermogravimetric analyzer using both nitrogen and air atmospheres are presented. Experimental data on smoke evolution are given, and the methodology for assessing the relative toxicity of the pyrolysis effluents is described. The values obtained from the flammability tests are compared with the stoichiometric char yield, and it is shown that the ignition tendency of the polymers is a linear function of the resin char yield.

A.A.

A79-33153 \* On the charge polarization of cosmic systems. A. Barnes (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). *Astrophysical Journal, Part 1*, vol. 229, Apr. 15, 1979, p. 679-681.

The positive electric charge density associated with the internal electric fields of self-gravitating systems in hydrostatic equilibrium can be canceled by nearby external flowing plasmas, such as winds. For example, it can be shown that the positive electric charge of a star is likely to be completely screened by its stellar wind. Because winds and other nonstatic phenomena are widespread, the electrical polarization due to the positive charge on static systems such as stars should occur on relatively local scales, in contrast to the universal scale recently suggested by Bally and Harrison. The latter viewpoint would be correct only if the entire universe were in strict hydrostatic equilibrium.

(Author)

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A79-33503 \* The seasonal variation of ozone density in the Martian atmosphere. T. Shimazaki (NASA, Ames Research Center, Moffett Field, Calif.) and M. Shimizu (NASA, Ames Research Center, Moffett Field, Calif.; Tokyo, University, Tokyo, Japan). *Journal of Geophysical Research*, vol. 84, Apr. 1, 1979, p. 1269-1276. 35 refs.

A one-dimensional, time-dependent model has been developed to investigate seasonal variations in ozone density in the Martian atmosphere. The model utilizes data for atmospheric temperature, pressure, and water vapor abundance observed by Viking. The results indicate that a high ozone density is not produced near the winter solstice but is in rather late winter, when the amount of water vapor is still small and the solar radiation can penetrate more deeply. A similar condition met in early winter does not necessarily produce a high ozone density because of the predicted higher HO<sub>2</sub> density. Seasonal variations in ozone abundance are discussed in terms of the abundances of H<sub>2</sub>O and H<sub>2</sub> and the seasonal variations in their reaction products H<sub>2</sub>O<sub>2</sub> and HO<sub>x</sub>. The roles of transport, the effects of ozone loss to the surface, and the differences between northern and southern hemisphere ozone distributions are also discussed.

(Author)

A79-33519 \* Precipitation fluxes of energetic electrons at Jupiter - An estimated upper limit. M. F. Thomsen and D. D. Sentman (Iowa, University, Iowa City, Iowa). *Journal of Geophysical Research*, vol. 84, Apr. 1, 1979, p. 1409-1418. 42 refs. Contract No. NAS2-6553.

Divine's (1976) model for the observed energetic electron fluxes in the inner Jovian magnetosphere is used to calculate space densities, and the combined source and loss term is evaluated for steady-state radial diffusion conserving the first and second adiabatic invariants. Upper-limit estimates for the ionospheric precipitation fluxes at various values of L and over various electron energy ranges are derived by assuming that contributions to the source term are negligible and that particle precipitation due to pitch-angle diffusion in the loss cone is the main contributor to the loss term. The energy deposition rates corresponding to these precipitated particles are estimated, along with the bremsstrahlung X-ray emissions that should result. It is found that the X-ray emissions should be 5 to 6 orders of magnitude below the reported upper observational limit.

F.G.M.

**A79-33527 \*** Radial diffusion of Io-injected plasma. C. K. Goertz and M. F. Thomsen (Iowa University, Iowa City, Iowa). *Journal of Geophysical Research*, vol. 84, Apr. 1, 1979, p. 1499-1504. 19 refs. NSF Grant No. ATM-76-82739; Contract No. NAS2-6553.

The paper reexamines the problem of particle injection by Io and subsequent radial diffusion by flux tube interchange using a proper phase space density formulation. The mathematical formalism is developed, and the theoretical results are compared with the observations, taking into account the pitch angle and energy coverage of the detector on Pioneer 10. Two objectives are pursued: (1) to test the hypothesis of Siscoe and Chen (1977) that Io is the source for all of the plasma observed by Frank et al. (1976) inside 10 RJ; and (2) to describe a simple but flexible method intended to analyze the observations of any other plasma instrument flown through the inner Jovian magnetosphere, e.g., those on Voyager 1 and 2 and Galileo.

S.D.

**A79-33992 \*** SOLARES - A new hope for solar energy. K. W. Billman, W. P. Gilbreath (NASA, Ames Research Center, Moffett Field, Calif.), and S. W. Bowen. In: *Alternative energy sources; Proceedings of the Miami International Conference*, Miami Beach, Fla., December 5-7, 1977. Volume 1. (A79-33984 13-44) Washington, D.C., Hemisphere Publishing Corp., 1978, p. 233-255. 13 refs.

A system of orbiting reflectors, SOLARES, has been studied as a possible means of reducing the diurnal variation and enhancing the average intensity of sunlight with a space system of minimum mass and complexity. The key impact that such a system makes on the economic viability of solar farming and other solar applications is demonstrated. The system is compatible with incremental implementation and continual expansion to meet the world's power needs. Key technology, environmental, and economic issues and payoffs are identified. SOLARES appears to be economically superior to other advanced, and even competitive with conventional, energy systems and could be scaled to completely abate our fossil fuel usage for power generation. Development of the terrestrial solar conversion technique, optimized for this new artificial source of solar radiation, yet remains.

(Author)

**A79-34211 \*** Infrared observations of NGC 2071/IRS/ and AFGL 490 - Two low-luminosity young stars. P. M. Harvey, M. F. Campbell, W. F. Hoffmann, H. A. Thronson, Jr. (Steward Observatory, Tucson, Ariz.), and I. Gatley (California Institute of Technology, Pasadena, Calif.). *Astrophysical Journal, Part 1*, vol. 229, May 1, 1979, p. 990-993. 30 refs. Grants No. NGR-03-002-390; No. NGR-05-002-281.

Infrared observations are presented of two compact sources associated with molecular clouds. Photometry from 2 to 200 microns of the source associated with an OH maser in NGC 2071, OH 205.1-14.1, shows a steep increase in flux from 2 to 50 microns. Scans at several wavelengths fail to resolve the source. Photometry at 50-200 microns of the other object, GL 490, when combined with earlier 2-20-micron spectrophotometry, shows an infrared energy distribution that is much broader than that of the NGC 2071 source. Both sources are interpreted as young, possibly pre-main-sequence objects with differences in energy distributions due principally to differences in the distribution of circumstellar matter.

(Author)

**A79-34226 \*** Landau damping effects on solar wind fast streams. N. D'Angelo, G. Joyce, and M. E. Pesses (Iowa University, Iowa City, Iowa). *Astrophysical Journal, Part 1*, vol. 229, May 1, 1979, p. 1138-1142. 18 refs. NSF-supported research; Grant No. NGL-16-001-043; Contract No. NAS2-6553.

Recent measurements by the Pioneer 10 and Helios 1 spacecraft show that the leading edge of a corotating structure spreads as it moves from 0.3 AU to the orbit of the earth and steepens again farther out. By including Landau damping effects in the dynamical behavior of the streams, the above qualitative features can be accounted for.

(Author)

**A79-34237 \*** Star formation at a front - Far-infrared observations of AFGL 333. H. A. Thronson, Jr., P. M. Harvey (Steward Observatory, Tucson, Ariz.), and I. Gatley (California Institute of Technology, Pasadena, Calif.). *Astrophysical Journal, Part 2 - Letters to the Editor*, vol. 229, May 1, 1979, p. L133-L136. 23 refs. Grant No. NGR-03-002-390.

Far-infrared maps of AFGL 333 at 50 and 100 microns with 40 arcsec resolution are presented. The observed luminosity of about 14,000 suns, together with previous radio continuum observations, indicates that the source is powered by a 80.5 zero-age main-sequence star. The relatively low molecular density of about 1000 per cu cm inferred from the observed dust optical depth probably implies that AFGL 333 is not as young as the other H II/infrared objects, W3(A) and W3(OH), in the W3/W4 system. (Author)

**A79-34759 \*** Post Landsat-D advanced concept evaluation /PLACE/. L. D. Alexander, U. R. Alvarado (General Electric Co., Space Div., Philadelphia, Pa.), and F. S. Flatow (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: *Conference on Advanced Technology for Future Space Systems*, Hampton, Va., May 8-10, 1979, Technical Papers. (A79-34701 14-12) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 504-510. Contract No. NAS2-9580. (AIAA 79-0944)

The aim of the Post Landsat-D Advanced Concept Evaluation (PLACE) program was to identify the key technology requirements of earth resources satellite systems for the 1985-2000 period. The program involved four efforts: (1) examination of future needs in the earth resources area, (2) creation of a space systems technology model capable of satisfying these needs, (3) identification of key technology requirements posed by this model, and (4) development of a methodology (PRISM) to assist in the priority structuring of the resulting technologies.

B.J.

**A79-34760 \*** Future planetary probes for Jupiter and Saturn. A. J. Butts (Martin Marietta Aerospace, Denver, Colo.) and J. P. Murphy (NASA, Ames Research Center, Moffett Field, Calif.). In: *Conference on Advanced Technology for Future Space Systems*, Hampton, Va., May 8-10, 1979, Technical Papers. (A79-34701 14-12) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 511-518. 5 refs. (AIAA 79-0945)

The paper describes a study conducted to identify the technology developments that would allow deep atmospheric investigations of Jupiter and Saturn to proceed beyond currently planned investigation of the upper atmosphere. The study considered a deep probe mission that would provide the capability to scientifically examine planetary atmospheres to the 1000-bar level and 1400-K level. The major conclusions of the study are that (1) a probe designed for Jupiter can be used with minor changes for Saturn, (2) new science instrument technology developments are required, and (3) the only new technology developments required in the engineering subsystem are high pressure thermal insulation materials and advanced data processing techniques.

B.J.

**A79-34948 \*** Retarding potential analyzer for the Pioneer-Venus Orbiter Mission. W. C. Knudsen, J. Bakke (Lockheed Research Laboratories, Palo Alto, Calif.), K. Spenger, and V. Novak (Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung, Freiburg im Breisgau, West Germany). *Space Science Instrumentation*, vol. 4, Apr. 1979, p. 351-372. 23 refs. Bundesministerium für Forschung und Technologie Contract No. 01-Do238(RV 14-B 28/73); Contract No. NAS2-8811.

The retarding potential analyzer on the Pioneer-Venus Orbiter Mission has been designed to measure most of the thermal plasma parameters within and near the Venusian ionosphere. Parameters include total ion concentration, concentrations of the more abundant ions, ion temperatures, ion drift velocity, electron temperature, and low-energy (0-50 eV) electron distribution function. To accomplish these measurements on a spinning vehicle with a small telemetry bit rate, several functions, including decision functions not previously used in RPA's, have been developed and incorporated into this instrument. The more significant functions include automatic

electrometer ranging with background current compensation; digital, quadratic retarding potential step generation for the ion and low-energy electron scans; a current sampling interval of 2 ms throughout all scans; digital logic inflection point detection and data selection; and automatic ram direction detection. Extensive numerical simulation and plasma chamber tests have been conducted to verify adequacy of the design for the Pioneer Mission. (Author)

A79-35617 \* Compact H II regions in the far-infrared. H. A. Thronson, Jr. and D. A. Harper (Yerkes Observatory, Williams Bay, Wis.). *Astrophysical Journal, Part 1*, vol. 230, May 15, 1979, p. 133-148. 75 refs. Grants No. NGR-14-001-211; No. NGR-14-001-227.

Far-infrared (40-150 microns) observations of W51 (G49.5-0.4), K3-50, DR 21, NGC 7538, and W3(OH) are presented and discussed. At these wavelengths each source is dominated by a small bright component closely associated with a compact H II region. Their spectra can be explained as emission by dust at temperatures of 30-50 K. Some of the objects appear to be optically thick out to wavelengths of about 60 microns. Of the 10 source components in the five regions, at least four may be powered by pre-main-sequence stars. The far-infrared data are consistent with depletion of volatile components of the dust within compact H II regions, but do not clearly require destruction or expulsion of refractory grains. The bulk of the dust which emits primarily in the far-infrared must lie in a dense shell immediately outside the ionized zone. The sources are possible precursors to open clusters with stellar masses in the range from 1,000 to 10,000 solar masses. (Author)

A79-35672 \* A one-dimensional model describing aerosol formation and evolution in the stratosphere. I - Physical processes and mathematical analogs. II - Sensitivity studies and comparison with observations. R. P. Turco (R & D Associates, Marina Del Rey, Calif.), P. Hamill, O. B. Toon, R. C. Whitten (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.), and C. S. Kiang (National Center for Atmospheric Research, Boulder, Colo.). *Journal of the Atmospheric Sciences*, vol. 36, Apr. 1979, p. 699-736. 154 refs.

A new time-dependent one-dimensional model of the stratospheric sulfate aerosol layer is developed. The model treats atmospheric photochemistry and aerosol physics in detail and includes the interaction between gases and particles explicitly. It is shown that the numerical algorithms used in the model are quite precise. Sensitivity studies and comparison with observations are made. The simulated aerosol physics generates a particle layer with most of the observed properties. The sensitivity of the calculated properties to changes in a large number of aeronomic aerosol parameters is discussed in some detail. The sensitivity analysis reveals areas where the aerosol model is most uncertain. New observations are suggested that might help resolve important questions about the origin of the stratospheric aerosol layer. S.D.

A79-35829 \* Subsolidus convective cooling histories of terrestrial planets. G. Schubert (California, University, Los Angeles, Calif.), P. Cassen, and R. E. Young (NASA, Ames Research Center, Moffett Field, Calif.). *Icarus*, vol. 38, May 1979, p. 192-211. 65 refs. Grants No. NGR-05-007-317; No. NsG-7315.

The subsolidus convective cooling histories of terrestrial planets evolving from hot initial states are investigated quantitatively. A simple analytic model simulating average heat flux from a vigorously convecting mantle and incorporating a mantle viscosity proportional to mantle temperature and a lithosphere which thickens as the planet cools is employed. Heat flux from the convecting mantle is calculated on the basis of a power law relation between Nusselt number and Rayleigh number. The temperature distribution in the lithosphere is assumed to be linear throughout the cooling history of the planet. Cooling histories have been determined for the earth, Mars, Mercury and the moon and the mantle temperature decreases, mantle viscosity increases and decreases of heat flux to the surface and to the base of the lithosphere and of Nusselt and Rayleigh

numbers are illustrated for each planet. It is found that primordial heat can contribute substantially to the present surface heat flux of a planet. A.L.W.

A79-36427 \* The energetics of the ionosphere of Venus - A preliminary model based on Pioneer Venus observations. T. E. Cravens, A. F. Nagy, R. H. Chen (Michigan, University, Ann Arbor, Mich.), L. H. Brace (NASA, Goddard Space Flight Center, Greenbelt, Md.), and W. C. Knudsen (Lockheed Research Laboratories, Palo Alto, Calif.). *Geophysical Research Letters*, vol. 6, May 1979, p. 341-344. 32 refs. Contract No. NAS2-9130; Grant No. NGR-23-005-015.

A model of the energy balance of the dayside ionosphere of Venus is presented. The coupled energy equations for electrons and ions are solved numerically and the calculated temperatures are compared with temperatures measured by instruments on the Pioneer Venus Orbiter. Neutral and ion density profiles consistent with those measured by various Pioneer Venus experiments are used in the model. It was found that using standard EUV sources and thermal conductivities the calculations produce temperatures that are much lower than the measured ones. Consequently, further calculations were performed in which (1) the thermal conductivities were inhibited by means of an almost horizontal magnetic field and/or (2) heat inflow into both the electron and ion gas at the top of the ionosphere was assumed due to the solar wind interaction. It was found that the calculated and measured temperatures were in reasonably good agreement if the thermal conductivities were inhibited by a near horizontal field of  $abc \cdot 10$  gammas and if the electron and ion heat fluxes were taken to be  $4 \times 10$  to the 9th eV/sq cm/sec and 10 to the 7th eV/sq cm/sec, respectively. (Author)

A79-36429 \* Plasma diffusion into the wake of Venus. T. Gombosi (Michigan, University, Ann Arbor, Mich.; Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezet, Budapest, Hungary), T. E. Cravens, A. F. Nagy (Michigan, University, Ann Arbor, Mich.), L. H. Brace (NASA, Goddard Space Flight Center, Greenbelt, Md.), and A. J. Owens (Delaware, University, Newark, Del.). *Geophysical Research Letters*, vol. 6, May 1979, p. 349-352. 17 refs. Contract No. NAS2-9130; Grant No. NGR-23-005-015.

A model of the diffusion of ionosheath plasma into the wake region of Venus is presented. It is shown that particle diffusion, which is assumed to be a consequence of the fluctuating magnetic field observed in the wake of Venus by Pioneer Venus and Veneras 9 and 10, can explain the plasma observations made in the wake by Veneras 9 and 10. The pressure due to these diffusing particles when balanced against the ionospheric pressure yield ionopause heights less than 1000 km for zenith angles less than about 135 deg. The model also predicts significant fluxes of low energy electrons and ions for zenith angles less than 135 deg, which are capable of producing the observed nightside ionosphere. (Author)

A79-37129 \* Phase relations in the Fe-Ni-Cr-S system and the sulfidation of an austenitic stainless steel. K. T. Jacob, D. B. Rao (NASA, Ames Research Center, Materials and Physical Science Branch, Moffett Field; California, University, Lawrence Berkeley Laboratory, Berkeley, Calif.), and H. G. Nelson (NASA, Ames Research Center, Materials and Physical Science Branch, Moffett Field, Calif.). *Oxidation of Metals*, vol. 13, Feb. 1979, p. 25-55. 53 refs. ERDA-supported research; Grant No. NCA2-OR050-706.

A79-37164 \* Nucleation, growth, and postdeposition thermally induced epitaxy of gold on sapphire. K. Heinemann, H. K. Kim, and H. Poppa (NASA/Stanford, Joint Institute for Surface and Microstructure Research, Moffett Field, Calif.). (*American Vacuum Society, National Symposium, 25th, San Francisco, Calif., Nov. 27-Dec. 1, 1978.*) *Journal of Vacuum Science and Technology*, vol. 16, Mar.-Apr. 1979, p. 622-624. 16 refs. NSF Grant No. DMS-76-P-44; Grant No. NsG-2249.

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**A79-37167 \*** Pioneer Venus large probe neutral mass spectrometer. J. H. Hoffman, R. R. Hodges, and K. D. Duerksen (Texas, University, Richardson, Tex.). (*American Vacuum Society, National Symposium, 25th, San Francisco, Calif., Nov. 27-Dec. 1, 1978*). *Journal of Vacuum Science and Technology*, vol. 16, Mar.-Apr. 1979, p. 692-694. Contract No. NAS2-8802.

The Pioneer Venus large probe neutral mass spectrometer (LNMS) uses a single focusing magnetic sector field mass analyzer with mass range of 1-208 amu, resolution sufficient to separate the mercury isotopes, and sensitivity sufficient to detect minor constituents in the 1 ppm range relative to the CO<sub>2</sub> in the Venus atmosphere. A combination of ion and chemical pumping is used to maintain a vacuum in the mass analyzer and to remove the atmosphere gases which enter the ion source chamber through a special leak. A microprocessor controls the operation of the instrument through a highly efficient peak stepping and data compression program, permitting acquisition of a complete mass spectrum roughly once each minute. P.T.H.

**A79-37422 \* #** Cosmic ray intensity gradients in the outer solar system measured by Pioneer 10 and 11. R. B. McKibben, J. J. O'Gallagher, K. R. Pyle, and J. A. Simpson (Chicago, University, Chicago, Ill.). In: *International Cosmic Ray Conference, 15th, Plovdiv, Bulgaria, August 13-26, 1977, Conference Papers, Volume 3*. (A79-37301 15-93) Sofia, B'lgarska Akademija na Naukite, 1978, p. 240-245. 7 refs. NSF Grant No. ATM-75-20407; Contract No. NAS2-6551.

Earlier results are extended to include data from Pioneer 10 to a radial range of 11.3 AU, and from Pioneer 11 inward from 5 AU to 3.75 AU after Jupiter encounter, and to a maximum heliographic latitude of 17 deg. The data include the period from March 1972 through October 1976, during which time the neutron monitor cosmic ray intensity was, except for a few significant excursions, near solar minimum level. It is shown that the radial gradients of all particle species considered are small and positive throughout the period of study. On a shorter time scale, the data indicate transient decreases in the value of the differential gradient associated with major decreases in the cosmic ray intensity in the inner solar system. The observations are consistent with a modulating region whose radius is large compared to 11 AU. The 'anomalous' helium component, present since 1972 at earth orbit, is observed continuously at all radial distances. S.D.

**A79-37525 \* #** Jupiter's magnetosphere as a 'point source' for electrons propagating from 1 to 12 AU. D. L. Chenette, T. F. Conlon, K. R. Pyle (Chicago, University, Chicago, Ill.), and J. A. Simpson. In: *International Cosmic Ray Conference, 15th, Plovdiv, Bulgaria, August 13-26, 1977, Conference Papers, Volume 5*. (A79-37301 15-93) Sofia, B'lgarska Akademija na Naukite, 1978, p. 226-231. 12 refs. NSF Grant No. ATM-75-20407; Contract No. NAS2-6551.

A profile of electron intensities in the interplanetary medium from 1 to 12 AU obtained from Pioneer 10 measurements of the 3-6 MeV Jovian electron flux shows recurring intensity peaks, the amplitude of which decreases with increasing distance from Jupiter both in the direction of the sun and away from it. Concurrent IMP-8 measurements of the 2-12 MeV electron flux revealed a series of 27-day recurrent intensity increases modulated with a period of about 13 months, beginning about four months before the probable magnetic field connection between earth and Jupiter. Amplitudes of the intensity increases reached a maximum near the time of best connection. These results are consistent with a three-dimensional interplanetary diffusion model with Jupiter as a continuously emitting point source. C.K.D.

**A79-37688 \*** Direct observation of voltage barriers in ZnO varistors. O. L. Krivanek, P. Williams, and Y.-C. Lin (California, University, Berkeley, Calif.). *Applied Physics Letters*, vol. 34, June 1, 1979, p. 805, 806. 13 refs. Research supported by the U.S. Department of Energy; NSF Grant No. DMR-77-24022; Grant No. NCA2-OR050-705.

Voltage barriers in a ZnO varistor have been imaged by voltage-contrast scanning electron microscopy. They are due to grain boundaries and are capable of supporting voltage differences of up to about 4 V. (Author)

**A79-37825 \*** Nonresonance rotation of Venus. I. I. Shapiro (MIT, Cambridge, Mass.), D. B. Campbell (National Astronomy and Ionosphere Center, Arecibo, P.R.), and W. M. DeCampi (Harvard University, Cambridge, Mass.). *Astrophysical Journal, Part 2 - Letters to the Editor*, vol. 230, June 1, 1979, p. L123-L126. 14 refs. Contract No. NAS2-9483.

Radar observations accumulated over the past 14 yr are used to make a precise estimate of the spin vector of Venus. The results obtained show that the spin vector of Venus may be adequately described in the standard 1950.0 coordinate system by a period of 243.01 + or - 0.03 days (retrograde) and a north pole direction corresponding to alpha = 272.8 + or - 0.5 deg and delta = 67.2 + or - 0.3 deg; the quoted errors represent estimates of 70% confidence intervals. The angular separations between the spin vector and those vectors representing the unit normals to the invariable plane of the solar system and the orbital plane of Venus are found to be 0.5 deg and 2.6 deg, respectively. It is concluded that Venus is not rotating with a resonance spin period relative to the orbit of earth and that the spin of Venus may be in a generalized Cassini state. F.G.M.

**A79-38026 \* #** A general and computationally fast formulation for radiative transfer with scattering. A. C. Cogley and A. Sharma (Illinois, University, Chicago, Ill.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 14th, Orlando, Fla., June 4-6, 1979, Paper 79-1035*. 9 p. 15 refs. NSF Grant No. 77-11713; Grant No. NCA2-OR330-701.

A general formulation of monochromatic radiative transfer with scattering has been developed for plane-parallel geometry. The inhomogeneous and nonisothermal medium absorbs, emits, and anisotropically scatters radiation. Surfaces can emit and scatter radiation in any specified manner. The solution procedure uses the fact that phase incoherent scattering is linear in radiative sources. Certain basic scattering functions are then defined and calculated by an adding computer code using matrix algebra. These scattering functions are weighted by the temperature field and summed (superimposed) to obtain the solution for any specific problem. Numerical results for exiting intensities and one-sided heat fluxes from general media bound by one arbitrary surface are presented. These parametric studies demonstrate the effects of scattering particles and surfaces on radiative transfer from inhomogeneous and nonisothermal media. Application of the formulation to radiative equilibrium is also discussed. The conclusion is that all problems in plane-parallel radiative transfer with scattering can be solved by a common and computationally fast algorithm based on this formulation. (Author)

**A79-38059 \* #** Time-dependent local density measurements in unsteady flows. R. L. McKenzie, D. J. Monson, and R. J. Exberger (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 14th, Orlando, Fla., June 4-6, 1979, Paper 79-1088*. 5 p. 8 refs.

A laser-induced fluorescence technique for measuring the relative time-dependent density fluctuations in unsteady or turbulent flows is demonstrated. Using a 1.5-W continuous-wave Kr(+) laser, measurements have been obtained in 0.1-mm diameter by 1-mm-long sampling volumes in a Mach 3 flow of N<sub>2</sub> seeded with biacetyl vapor. A signal amplitude resolution of 2% was achieved for a detection frequency bandwidth of 10 kHz. The measurement uncertainty was found to be dominated by noise behaving as photon statistical noise. The practical limits of signal-to-noise ratios have been characterized for a wide range of detection frequency bandwidths that encompasses those of interest in supersonic turbulence measurements. (Author)

**A79-38123 \*** # **Transient ablation of Teflon in intense radiative and convective environments.** N. Arai (NASA, Ames Research Center, Moffett Field, Calif.). *AIAA Journal*, vol. 17, June 1979, p. 634-640. 13 refs.

On the basis of this investigation of the high-temperature behavior of polytetrafluoroethylene (PTFE), the transient one-dimensional ablation of PTFE has been developed by taking into account the optical transmittance of both the amorphous zone and the crystalline zone of PTFE layer. Results show that although the exposed surface receded at an apparently steady state, both the internal temperature and the thickness of the gel layer increase continuously due to the internal absorption of radiation. (Author)

**A79-38289 \*** # **An orbiting infrared interferometer to search for nonsolar planets.** R. H. MacPhie (Waterloo University, Waterloo, Ontario, Canada) and R. N. Bracewell (Stanford University, Stanford, Calif.). In: *Instrumentation in astronomy III; Proceedings of the Seminar, Tucson, Ariz., January 29-February 1, 1979.* (A79-38256 16-35) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 271-278. 10 refs. Grant No. NCA2-OR745-716.

This paper proposes an orbiting infrared interferometer with its fringe null centered on a nearby star at a distance of say 10 parsecs. A large planet ('Jupiter') would have an angular separation from the star of about 0.5 arcsec. To have a fringe crest on the planet, a fringe period of 1.0 arcsec is needed and at 40 microns the required baseline is 8 m. Spinning the interferometer about the line of sight to the star results, even with pointing errors, in a relatively slowly varying but strongly suppressed stellar output and a more rapidly varying fringe-like planetary signal rich in higher harmonics. For pointing errors up to .050 arcsec the planet's fourth harmonic greatly exceeds that from the star, thereby relaxing interferometer pointing tolerances. Indeed, it appears that the limiting factor is zodiacal infrared background radiation and not the intense localized stellar flux which can effectively be eliminated by the fringe null of the spinning infrared interferometer. (Author)

**A79-38562 \*** # **Line-by-line transport calculations for Jupiter entry probes.** J. O. Arnold, D. M. Cooper, C. Park (NASA, Ames Research Center, Moffett Field, Calif.), and S. G. Prakash (Stanford University, Stanford, Calif.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 14th, Orlando, Fla., June 4-6, 1979, Paper 79-1082.* 17 p. 44 refs.

Line-by-line calculations of the radiative transport for a condition near peak heating for entry of the Galileo probe into the Jovian atmosphere are described. The discussion includes a thorough specification of the atomic and molecular input data used in the calculations that could be useful to others working in the field. The results show that the use of spectrally averaged cross sections for diatomic absorbers such as CO and C<sub>2</sub> in the boundary layer can lead to an underestimation (by as much as 29%) of the spectral flux at the stagnation point. On the other hand, for the turbulent region near the cone frustum on the probe, the flow tends to be optically thin, and the spectrally averaged results commonly used in coupled radiative transport-flow field calculations are in good agreement with the present line-by-line results. It is recommended that these results be taken into account in sizing the final thickness of the Galileo's heat shield. (Author)

**A79-38567 \*** # **Numerical simulation of experiments in the Giant Planet Facility.** M. J. Green and W. C. Davy (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 14th, Orlando, Fla., June 4-6, 1979, Paper 79-1102.* 13 p. 29 refs.

Utilizing a series of existing computer codes, ablation experiments in the Giant Planet Facility are numerically simulated. Of primary importance is the simulation of the low Mach number shock layer that envelops the test model. The RASLE shock-layer code, used in the Jupiter entry probe heat-shield design, is adapted to the experimental conditions. RASLE predictions for radiative and convective heat fluxes are in good agreement with calorimeter

measurements. In simulating carbonaceous ablation experiments, the RASLE code is coupled directly with the CMA material response code. For the graphite models, predicted and measured recessions agree very well. Predicted recession for the carbon phenolic models is 50% higher than that measured. This is the first time codes used for the Jupiter probe design have been compared with experiments.

(Author)

**A79-38684 \*** # **The Karhunen-Loeve, discrete cosine, and related transforms obtained via the Hadamard transform.** H. W. Jones (COM-CODE, Inc., Mountain View, Calif.), D. N. Hein (Kansas State University of Agriculture and Applied Science, Manhattan, Kan.), and S. C. Knauer (NASA, Ames Research Center, Moffett Field, Calif.). In: *ITC/USA/78; Proceedings of the International Telemetering Conference, Los Angeles, Calif., November 14-16, 1978.* (A79-38676 16-32) Pittsburgh, Pa., Instrument Society of America, 1978, p. 87-98. 11 refs. Contract No. NAS2-9703; Grant No. NCA2-OR363-702.

A general class of even/odd transforms is presented that includes the Karhunen-Loeve transform, the discrete cosine transform, the Walsh-Hadamard transform, and other familiar transforms. The more complex even/odd transforms can be computed by combining a simpler even/odd transform with a sparse matrix multiplication. A theoretical performance measure is computed for some even/odd transforms, and two image compression experiments are reported.

P.T.H.

**A79-38694 \*** # **Bandwidth compression of multispectral satellite imagery.** A. Habibi (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: *ITC/USA/78; Proceedings of the International Telemetering Conference, Los Angeles, Calif., November 14-16, 1978.* (A79-38676 16-32) Pittsburgh, Pa., Instrument Society of America, 1978, p. 199-205. 11 refs. Contract No. NAS2-8394.

The results of two studies aimed at developing efficient adaptive and nonadaptive techniques for compressing the bandwidth of multispectral images are summarized. These techniques are evaluated and compared using various optimality criteria including MSE, SNR, and recognition accuracy of the bandwidth compressed images. As an example of future requirements, the bandwidth requirements for the proposed Landsat-D Thematic Mapper are considered.

B.J.

**A79-38718 \*** # **A class of programmable satellite receivers.** S. W. Klare (Motorola, Inc., Government Electronics Div., Scottsdale, Ariz.). In: *ITC/USA/78; Proceedings of the International Telemetering Conference, Los Angeles, Calif., November 14-16, 1978.* (A79-38676 16-32) Pittsburgh, Pa., Instrument Society of America, 1978, p. 509-520. 6 refs. Contracts No. NAS2-9707; No. JPL-954308.

The primary purpose of programmable satellite receivers is to provide flexibility in application through digital control of the important functions of the receiver. This permits the acquisition and demodulation of medium to very low data rates in widely varying communications environments and over a wide range of modulation schemes. The first application of the programmable concept is in the high-reliability, low-power NASA Standard Command Detector Unit. A second programmable receiver has been designed and breadboarded for the Jupiter Orbiter Probe or Galileo mission.

B.J.

**A79-38912 \*** # **Preferential spectral transport by irrotational straining.** K. Hanjalic and B. E. Launder (California, University, Davis, Calif.). In: *Turbulent boundary layers: Forced, incompressible, non-reacting.* Proceedings of the Joint Applied Mechanics, Fluids Engineering and Bioengineering Conference, Niagara Falls, N.Y., June 18-20, 1979. (A79-38901 16-34) New York, American Society of Mechanical Engineers, 1979, p. 101-109. 26 refs. Grant No. NSG-2256.

The addition of an extra term to the conventional approximate transport equation for the turbulence energy dissipation rate is recommended. The term may be viewed as emphasizing the role of irrotational deformations in promoting energy transfer across the spectrum or, equivalently, as augmenting the influence of normal strains. Calculations including the new term are reported for the plane and round jet and for several turbulent boundary layers. In the cases considered the addition of the new term significantly improves agreement with experimental data.

B.J.

**A79-38926 \*** # A prediction method for velocity and temperature profiles in a two-dimensional nominally steady turbulent boundary layer. G. G. Neigand (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.) and J. D. A. Walker (Lehigh University, Bethlehem, Pa.). In: Turbulent boundary layers: Forced, incompressible, non-reacting; Proceedings of the Joint Applied Mechanics, Fluids Engineering and Bioengineering Conference, Niagara Falls, N.Y., June 18-20, 1979. (A79-38901 16-34) New York, American Society of Mechanical Engineers, 1979, p. 221-235. 32 refs. Grant No. NSG-2135.

This paper describes a recently developed boundary-layer prediction method for a variable property compressible flow, in which heat transfer takes place primarily by forced convection and for which the mainstream Mach number is small. The leading order terms, in asymptotic expansions for large Reynolds numbers, are obtained for the mean velocity and temperature distribution in both the inner and outer layer of the turbulent boundary layer. Closure in the inner layer is achieved using an analytical model for the mean profiles which is based on the observed coherent structure of the time-dependent inner layer flow. For the outer layer, simple eddy viscosity and conductivity models are developed without recourse to the Reynolds analogy. In the prediction method a numerical solution of the outer layer equations is matched to the analytical inner layer profiles as the computation proceeds downstream. Calculations are presented for a range of adverse and favorable pressure gradient flows and the predicted results compare well with existing data. (Author)

**A79-39117 \*** Crustal evolution inferred from Apollo magnetic measurements. P. Dyal (NASA, Ames Research Center, Moffett Field, Calif.), W. D. Daily (Eyring Research Institute, Provo, Utah), and L. L. Van'ian (Akademii Nauk SSSR, Institut Kosmicheskikh Issledovaniy, Moscow, USSR). In: Lunar and Planetary Science Conference, 9th, Houston, Tex., March 13-17, 1978, Proceedings. Volume 1. (A79-39107 16-91) New York, Pergamon Press, Inc., 1978, p. 231-248. 22 refs. Grant No. NSG-2082.

The topology of lunar remanent fields is investigated by analyzing simultaneous magnetometer and solar wind spectrometer data. The diffusion model proposed by Vanyan (1977) to describe the field-plasma interaction at the lunar surface is extended to describe the interaction with fields characterized by two scale lengths, and the extended model is compared with data from three Apollo landing sites (Apollo 12, 15 and 16) with crustal fields of differing intensity and topology. Local remanent field properties from this analysis are compared with high spatial resolution magnetic maps obtained from the electron reflection experiment. It is concluded that remanent fields over most of the lunar surface are characterized by spatial variations as small as a few kilometers. Large regions (50 to 100 km) of the lunar crust were probably uniformly magnetized early in the evolution of the crust. Smaller scale (5 to 10 km) magnetic sources close to the surface were left by bombardment and subsequent gardening of the upper layers of these magnetized regions. The small scale sized remanent fields of about 100 gammas are measured by surface experiments, whereas the larger scale sized fields of about 0.1 gammas are measured by the orbiting subsatellite experiments. C.K.D.

**A79-39285 \*** Mare volcanism in the Herigonius region of the moon. R. Greeley (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif., Arizona State University, Tempe, Ariz.) and P. D. Spudis (Arizona State University, Tempe, Ariz.). In: Lunar and Planetary Science Conference, 9th, Houston, Tex., March 13-17, 1978, Proceedings. Volume 3. (A79-39253 16-91) New York, Pergamon Press, Inc., 1978, p. 3333-3349. 24 refs. Grants No. NSG-7141; No. NSG-7429.

The paper considers the area in the vicinity of the crater Herigonius. This area contains numerous sinuous rilles, craters with irregular planimetric form, possible pyroclastic cones, and other features of probable volcanic origin, and appears to be the vent region that supplied lavas both northward to Oceanus Procellarum and southward to the Humorum basin. The approach used involves photogeologic interpretation of surface features and mapping of mare units to derive a regional stratigraphic sequence. The sequence of mare volcanism provides insight into the complex emplacement of lunar lavas and the general volcanic history of the moon. S.D.

**A79-39309 \*** Size-frequency distributions of primary and secondary lunar impact craters. D. E. Wilhelms (U.S. Geological Survey, Menlo Park, Calif.), V. R. Oberbeck, and H. R. Aggarwal (NASA, Ames Research Center, Moffett Field, Calif.). In: Lunar and Planetary Science Conference, 9th, Houston, Tex., March 13-17, 1978, Proceedings. Volume 3. (A79-39253 16-91) New York, Pergamon Press, Inc., 1978, p. 3735-3762. 45 refs. NASA Order W-13130.

The graphs of diameter vs frequency plotted in the present study for primary impact craters produced in four time intervals exhibit an appreciable change in form with age. A deficiency of small craters relative to an extrapolation from the large-diameter parts of the curves is greatest and extends to the largest sizes in the oldest population (pre-Nectarian), whose curve approximates a log-normal form. Successively younger populations (Nectarian, Imbrian, Copernican plus Eratosthenian) have successively more small craters relative to larger ones and more nearly log-log distributions. Many of the craters thought to be small old primaries are here identified as secondary craters of basins, on the basis of previously developed criteria. V.P.

**A79-39310 \*** A composition and thickness model for lunar impact crater and basin deposits. R. H. Morrison (LFE Corp., Richmond, Calif.) and V. R. Oberbeck (NASA, Ames Research Center, Moffett Field, Calif.). In: Lunar and Planetary Science Conference, 9th, Houston, Tex., March 13-17, 1978, Proceedings. Volume 3. (A79-39253 16-91) New York, Pergamon Press, Inc., 1978, p. 3763-3785. 45 refs.

A model was developed for determining the composition and thicknesses of continuous deposits of large lunar impact craters and basins. Results of a photogeologic study and topographic analysis of continuous deposits of the lunar crater Delisle, which support the model, show that numerous secondary craters and crater chains with concentric dunes on their uprange rims occur well within the mapped deposits. At any given radius from Delisle, the secondary craters are of equal freshness and not vastly different in size, but with increasing radius they become better defined. The upper surface of the continuous deposits reaches the level of the pre-existing mare surface well within the mapped boundary of the deposits. V.P.

**A79-39314 \*** Experimental studies of oblique impact. D. E. Gault (California Institute of Technology, Pasadena, Murphys Center of Planetary, Murphys, Calif.) and J. A. Wedekind (NASA, Ames Research Center, Moffett Field, Calif.). In: Lunar and Planetary Science Conference, 9th, Houston, Tex., March 13-17, 1978, Proceedings. Volume 3. (A79-39253 16-91) New York, Pergamon Press, Inc., 1978, p. 3843-3875. 34 refs.

Meteoritic materials most probably impact planetary bodies along oblique trajectories inclined less than 45 deg above their surfaces. Laboratory studies of hypervelocity impacts against rock and particulate media are presented that indicate important effects of obliquity on crater size, shape, and ejecta distribution. The effects are particularly important to crater size-frequency analyses and geologic interpretations of crater formations. Impacts at shallow incidence, which are not uncommon, lead to ricochet of the impacting object accompanied with some entrained excavated materials at velocities only slightly reduced from the pre-impact value. (Author)

**A79-39950 \*** Bonding of nitrogen atoms on Cu(001) surfaces - A cluster approach. H. L. Yu (NASA/Stanford, Joint Institute for Surface and Microstructural Research, Moffett Field, Calif.) and E. E. Whiting (NASA, Ames Research Center, Moffett Field, Calif.). *Surface Science*, vol. 82, 1979, p. 301-314. 25 refs.

A study of the chemisorption of nitrogen atoms on a copper surface has been performed, based on an analysis of the electronic structure of the Cu<sub>5</sub>N cluster obtained from self-consistent field X-alpha scattered-wave calculations. Calculations show that the chemisorption of nitrogen on Cu(001) surfaces induces peaks below and above the Cu d-band region in the total density of states curve. The bonding orbitals formed between the N 2p and the Cu valence orbitals are generally found near the bottom of the Cu d-band region, while the antibonding orbitals formed between the N 2p and Cu

orbitals are found to lie above the Cu d-band region. These hybridized orbitals involving the N 2p orbital gave a satisfactory interpretation of the adsorbate-induced structure reported in N/Cu(001) ultraviolet photoemission studies. (Author)

A79-40056 \* Laser-stimulated migration of adsorbed atoms on solid surfaces. M. S. Slutsky (Rochester, University, Rochester, N.Y.) and T. F. George. *Journal of Chemical Physics*, vol. 70, Feb. 1, 1979, p. 1231-1235. 16 refs. NSF Grant No. CHE-77-27826; Contract No. F49620-78-0005; Grant No. NSG-2198.

This paper presents a unified theory of the coherent, multiple-photon excitation and laser-stimulated migration of atoms adsorbed on solid surfaces. We show that under steady-state excitation the migration of the adsorbed atom on the surface is diffusional, with diffusion constant dependent upon field intensity, surface temperature, relaxation constants, dipole moment strength, laser frequency, and the vibrational frequency of the adsorbed atom. In particular, it is shown that the rate of diffusion is proportional to the field intensity. Finally, we discuss the utility of laser-stimulated migration in the enhancement of surface chemical reactions, as well as in the analysis of surface relaxational processes. (Author)

A79-40087 \* Internal photoemission in Ag-Al<sub>2</sub>O<sub>3</sub>-Al junctions. J. M. P. Guedes, C. W. Slayman, T. K. Gustafson (California, University, Berkeley, Calif.), and R. K. Jain (Hughes Research Laboratories, Malibu, Calif.). *IEEE Journal of Quantum Electronics*, vol. QE-15, June 1979, p. 475-481. 25 refs. Grant No. NSG-2151; Contract No. F44620-76-C-0100.

The magnitude of the photon-induced current in Ag-Al<sub>2</sub>O<sub>3</sub>-Al metal-oxide-metal junctions has been studied as a function of photon energy and angle of incident radiation. Photocurrents were theoretically analyzed on the basis of a modified vacuum photoemission model (Jain, 1975; Slayman et al., to be published). Optical constants previously reported in the literature (Irani et al., 1971; Ehrnreich et al., 1963) were used to calculate the true spatial generation rate in Ag and Al as a function of the angle, polarization of incident radiation, and film thickness. Results were found to be in very good agreement with experimentally determined values for a tunable dye laser with a KDP doubling crystal pumped by a Q-switched Nd:YAG laser with a LiIO<sub>3</sub> doubling crystal. The system provided risetimes of 50 ns or less and peak powers of 10 W. Under short circuit conditions, the photoresponse to incident power was linear up to available power densities of 10 kW/sq cm. Quantum efficiencies of about 0.1% at zero-bias, near 3.8 eV under P polarization, were typically observed. C.K.D.

A79-40492 \* Atomic electron excitation probabilities during orbital electron capture by the nucleus. B. Censemann, M. H. Chen (Oregon University, Eugene, Ore.), J. P. Briand, P. Chevallier, A. Chetioui, and M. Tavernier (Paris, Université, Institut du Radium, Paris VI, Université, Paris, France). *Physical Review C - Nuclear Physics*, 3rd Series, vol. 19, Mar. 1979, p. 1042-1046. 18 refs. Grants No. NGR 38-003-036; No. DAAG29-76-G-0010.

Approximate probabilities of electric excitation (shakeup/shakeoff) from various atomic states during nuclear ns electron capture have been calculated in the sudden approximation, using Hartree-Fock wave functions. Total excitation probabilities are much lower than during inner-shell ionization by photons or electrons, and ns states are more likely to be excited than np states. This latter result is borne out by K-alpha X-ray satellite spectra. (Author)

A79-40502 \* # A versatile microprocessor-controlled hybrid receiver. T. L. Grant (NASA, Ames Research Center, Moffett Field, Calif.). In: NTC '78, National Telecommunications Conference, Birmingham, Ala., December 3-6, 1978, Conference Record, Volume 1. (A79-40501 17-32) Piscataway, N.J., Institute of Electrical and Electronics Engineers, Inc., 1978, p. 2.1.1-2.1.5.

A hybrid receiver has been designed for the Galileo Project. The receiver, located on the Galileo Orbiter, will autonomously acquire and track signals from the first atmospheric probe of Jupiter as well as demodulate, bit-synchronize, and buffer the telemetry data. The

receiver has a conventional RF and LF front end but performs multiple functions digitally under firmware control. It will be a self-acquiring receiver that operates under a large frequency uncertainty; it can accommodate different modulation types, bit rates, and other parameter changes via reprogramming. A breadboard receiver and test set demonstrate a preliminary version of the sequential detection process and verify the hypothesis that a fading channel does not reduce the probability of detection. B.J.

A79-40600 \* Theory of molecular rate processes in the presence of intense laser radiation. T. F. George, I. H. Zimmerman, P. L. DeVries, J.-M. Yuan, K.-S. Lam, J. C. Bellum, H.-W. Lee, M. S. Slutsky, and J.-T. Lin (Rochester, University, Rochester, N.Y.). In: *Chemical and biochemical applications of lasers*. New York, Academic Press, Inc., 1979, p. 253-354. 126 refs. NSF Grant No. CHE-77-27826; Grant No. NSG-2198; Contract No. F49620-78-C-0005.

The present paper deals with the influence of intense laser radiation on gas-phase molecular rate processes. Representations of the radiation field, the particle system, and the interaction involving these two entities are discussed from a general rather than abstract point of view. The theoretical methods applied are outlined, and the formalism employed is illustrated by application to a variety of specific processes. Quantum mechanical and semiclassical treatments of representative atom-atom and atom-diatom collision processes in the presence of a field are examined, and examples of bound-continuum processes and heterogeneous catalysis are discussed within the framework of both quantum-mechanical and semiclassical theories. V.P.

A79-40601 \* Anomalous features in thermal radiance maps of Venus. J. Apt and R. Goody (Harvard University, Cambridge, Mass.). *Journal of Geophysical Research*, vol. 84, June 1, 1979, p. 2529-2538. 15 refs. Contract No. NAS2-9127.

Seventeen thermal radiance maps of Venus were recorded in a 26-day interval near the 1977 conjunction. An average symmetrical two-dimensional function was removed from the data. Features remain near the east and west limbs which correspond in part to previously reported solar-related effects but there are important differences, and reasons are given for questioning the interpretation of some of the earlier data. It is concluded that these features cannot be solely under solar control. Features are also found at both poles, just inside the region covered by the ultraviolet polar hood. These are not inconsistent with disturbances rotating rapidly around the planet. There is weak evidence for a 5-day repetition in some features. (Author)

A79-40670 \* Millimetre and submillimetre measurements of the Crab Nebula. E. L. Wright (MIT, Cambridge, Mass.), D. A. Harper (Yerkes Observatory, Williams Bay, Wis.; Chicago, University, Chicago, Ill.), R. H. Hildebrand, J. Keene, and S. E. Whitcomb (Chicago, University, Chicago, Ill.). *Nature*, vol. 279, June 21, 1979, p. 703-705. 15 refs. Research supported by the Fannie and John Hertz Foundation; Grants No. NSG-2263; No. NSG-2057; No. NGR-14-001-227.

The flux from the central region of the Crab Nebula in three broad spectral passbands with flux-weighted mean wavelengths of 300 microns, 400 microns and 1 mm has been measured. The inferred total flux densities for the entire nebula are consistent with an extrapolation of the power law spectrum found at longer wavelengths. Derivations of various flux densities are presented, and it is concluded that the luminosity of dust emission from the Crab Nebula varies between 1300 and 5000 suns as the temperature varies from 40 to 120 K, respectively. C.F.W.

A79-40762 \* # The monopropellant hydrazine propulsion subsystem for the Pioneer Venus spacecraft. F. C. Barker (Hughes Aircraft Co., El Segundo, Calif.). AIAA, SAE and ASME, *Joint Propulsion Conference*, 15th, Las Vegas, Nev., June 18-20, 1979. AIAA Paper 79-1329. 9 p. Contract No. NAS2-8300.

The Pioneer Venus Orbiter and the Multiprobe spacecraft propulsion subsystems and their performance are presented. Monopropellant hydrazine subsystems on each spacecraft provided the capability to spin up the spacecraft after separation and perform all spin rate, velocity, and attitude changes required by the control subsystem to satisfy mission objectives. The propulsion subsystem provides thrust on demand by supplying anhydrous hydrazine from the propellant tanks through manifolds, filters and valves to the thrust chamber assemblies where the hydrazine is catalytically decomposed and expanded in a conical nozzle. The subsystems consist of seven 1 lbf thrusters for the Orbiter and six 1 lbf thrusters for the multiprobe which are isolated by two latch valves from the two propellant tanks so that two redundant thruster clusters are provided to ensure mission completion in the event of a single point failure. The propellant feed system is of all-welded construction to minimize weight and leakage and titanium is used as the primary material of construction. The multiprobe burned up on entering the Venus atmosphere with enough propellant left for the mission and the Orbiter was inserted into Venus orbit with enough propellant remaining for more than 2 earth years of orbital operations. A.T.

**A79-40788 \*** Fields and plasmas in the outer solar system. E. J. Smith (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and J. H. Wolfe (NASA, Ames Research Center, Moffett Field, Calif.). (COSPAR, IAU, IUGG, IUPAP, and URSI, International Symposium on Solar Terrestrial Physics, Innsbruck, Austria, May 29-June 3, 1978.) *Space Science Reviews*, vol. 23, Apr. 1979, p. 217-252. 72 refs. Contract No. NAS7-100.

The most significant data on fields and plasmas in the outer solar system, based on observations by Pioneer 10 and 11, are reviewed. Attention is given to (1) corotating shocks and the evolution of high speed solar wind streams, (2) the effect of the changing structure of the interplanetary medium on energetic particles, (3) the propagation of flare-generated shocks through the outer solar system, (4) radial gradients in the solar wind and interplanetary field, and (5) the dependence of the interplanetary sector structure on heliographic latitude. B.J.

**A79-40791 \*** The Jovian magnetodisk. C. K. Goertz (Iowa University, Iowa City, Iowa). (COSPAR, IAU, IUGG, IUPAP, and URSI, International Symposium on Solar Terrestrial Physics, Innsbruck, Austria, May 29-June 3, 1978.) *Space Science Reviews*, vol. 23, Apr. 1979, p. 319-343. 54 refs. NSF Grant No. ATM-76-82739; Contract No. NAS2-6553.

Magnetic field measurements made by the vector helium magnetometers on board Pioneers 10 and 11 reveal the existence of a current sheet (thickness of about 2 Jupiter radii) carrying an eastward current. Self-consistent studies of the current sheet show that the magnitude of the current is of the order of 0.01 Am and that the current is carried by a hot (T greater than 1 keV) plasma, the density of which varies between 1 cu cm at 30 Jupiter radii to 100 cu cm at 80 Jupiter radii. The current sheet is warped azimuthally and parallel to the magnetic dipole equator. The existence of an azimuthal field component indicates a poloidal plasma flow transporting some 10 to the 29th ions per second from Jupiter into the outer magnetosphere. It is shown that, if the outer magnetosphere is in a steady state, this plasma must be transported outward within the current sheet by a diffusion process which is faster than the one responsible for particle transport in the inner magnetosphere but slower than Bohm diffusion. (Author)

**A79-40809 \*** Encounter with Venus - An update. L. Colin (NASA, Ames Research Center, Moffett Field, Calif.). *Science*, vol. 205, July 6, 1979, p. 44-46.

This report deals with early results from the Pioneer Venus Orbiter and multiprobe missions, which encountered Venus on December 4 and December 9, 1978, respectively. Initial results for the multiprobe mission and for the first 30 days of the Orbiter

mission have already been reported. Additional mission features and updated mission parameters based on refined tracking data and trajectory computations are presented here. Scientific results for both missions are discussed which cover the first 130 days (or orbits) of the nominal 243-day Orbiter mission. (Author)

**A79-40810 \*** Thermal contrast in the atmosphere of Venus - Initial appraisal from Pioneer Venus probe data. A. Seiff, D. B. Kirk, R. E. Young, S. C. Sommer (NASA, Ames Research Center, Moffett Field, Calif.), R. C. Blanchard (NASA, Langley Research Center, Hampton, Va.), J. T. Findlay, and G. M. Kelly (Analytical Mechanics Associates, Inc., Hampton, Va.). *Science*, vol. 205, July 6, 1979, p. 46-49. 15 refs.

The altitude profiles of temperature and pressure were measured during the descent of four Pioneer Venus probes, showing small contrasts below the clouds, but significant differences within the clouds at altitudes from 45 to 61 km. Measurements of pressure differences were found to be consistent with the cyclostrophic balance of zonal winds ranging from 110 to 150 m/sec at 60 km and from 43 to 77 m/sec at 40 km. The clouds were 10 to 20 K warmer than the extended profiles of the lower atmosphere and the middle cloud is convectively unstable. Both phenomena are due to thermal radiation from below. Meridional wind velocities were studied, concluding that significant planetary scale non-axisymmetric motions were present at latitudes below 30 degrees. This result was consistent with the day-night pressure difference. Indications of flow oscillations in the lower atmosphere were noted and the inference of wave motions in the lower atmosphere was supported by analysis of oscillations in the Doppler residuals. C.F.W.

**A79-40811 \*** Composition and structure of the Venus atmosphere - Results from Pioneer Venus. J. H. Hoffman, R. R. Hodges, Jr. (Texas, Univ. of), Richardson, Tex.), M. B. McElroy (Harvard University, Cambridge, Mass.), T. M. Donahue (Michigan University, Ann Arbor, Mich.), and M. Kolpin (Physics International Co., San Leandro, Calif.). *Science*, vol. 205, July 6, 1979, p. 49-52. 12 refs. Contracts No. NAS2-8802, No. NAS2-9485.

The composition of the Venusian atmosphere was studied using a mass spectrometer on the Pioneer Venus sounder probe. The single-focusing magnetic-sector spectrometer scanned the mass range from hydrogen through mercury with a dynamic range of six decades. Data taken by the mass spectrometer were compared with those of a gas chromatograph, resulting in slight discrepancies due to the use of a sputter ion pump acting as a sink for entry of rare gases through the inlet leak. A surprisingly large concentration of primordial Ar-36 and Ar-38 was discovered in a ratio of 5 to 1. It was concluded that the large excess of primordial argon was a valid result and that the mixing of HCl in the lower Venusian atmosphere was less than a few parts per million. Arguments against the sun as the source for excess primordial gases on Venus were presented. Concentrations of other elements such as Ne, Kr, He, S, and O were discussed. Although the mass peaks in the spectrum were real, it was not clear whether all of the chemical reactions (i.e., COS production) actually occurred in the atmosphere. Until further analysis can be made, it will be uncertain how the inlet system, which is at atmospheric temperature, affected the results. C.F.W.

**A79-40814 \*** Implications of the gas compositional measurements of Pioneer Venus for the origin of planetary atmospheres. J. B. Polack and D. C. Black (NASA, Ames Research Center, Moffett Field, Calif.). *Science*, vol. 205, July 6, 1979, p. 56-59. 23 refs.

Comparisons are made between the volatile inventories of the terrestrial planets, including Pioneer Venus data, and the predictions of three classes of theories for the origin of planetary atmospheres. Serious difficulties arise for the primary atmosphere and external source hypotheses. The grain accretion hypothesis can account for the trends in the volatile inventory from Venus to earth to Mars, if volatiles were incorporated into planet-forming grains at nearly the same temperature for all of these planets, but at systematically lower pressures in the regions of planet formation farther from the center of the solar nebula. (Author)

**A79-40815 \*** Ultraviolet night airglow of Venus. A. I. Stewart and C. A. Barth (Colorado, University, Boulder, Colo.). *Science*, vol. 205, July 6, 1979, p. 59-62. 18 refs. Contract No. NAS2-9477.

The night airglow spectrum of Venus in the ultraviolet is dominated by the V-prime = 0 progressions of the gamma and delta bands of nitric oxide. The bands are produced by two-body radiative recombination of nitrogen and oxygen atoms. Since the source of these atoms is in the dayside thermosphere, the night airglow is a tracer of the day-to-night thermospheric circulation. The airglow is brightest at equatorial latitudes and at longitudes on the morning side of the antisolar meridian. (Author)

**A79-40821 \*** Nature of the ultraviolet absorber in the Venus clouds - Inferences based on Pioneer Venus data. J. B. Pollack, B. Ringer, R. Boese (NASA, Ames Research Center, Moffett Field, Calif.), M. G. Tomasko (Arizona, University, Tucson, Ariz.), J. Blamont (CNRS, Service d'Aéronomie, Verrières-le-Buisson, Essonne, France), R. G. Knollenberg (Particle Measuring Systems, Inc., Boulder, Colo.), L. W. Esposito, A. I. Stewart (Colorado, University, Boulder, Colo.), and L. Travis (NASA, Goddard Institute for Space Studies, New York, N.Y.). *Science*, vol. 205, July 6, 1979, p. 76-79. 28 refs.

Several photometric measurements of Venus made from the Pioneer Venus orbiter and probes indicate that solar near-ultraviolet radiation is being absorbed throughout much of the main cloud region, but little above the clouds or within the first one or two optical depths. Radiative transfer calculations were carried out to simulate both Pioneer Venus and ground-based data for a number of proposed cloud compositions. This comparison rules out models invoking nitrogen dioxide, meteoritic material, and volatile metals as the source of the ultraviolet absorption. Models involving either small (approximately 1 micrometer) or large (approximately 10 micrometers) sulfur particles have some serious difficulties, while ones invoking sulfur dioxide gas appear to be promising. (Author)

**A79-40824 \*** Venus winds are zonal and retrograde below the clouds. C. C. Counselman, III, S. A. Gourevitch, R. W. King, G. B. Loriot, and R. G. Prinn (MIT, Cambridge, Mass.). *Science*, vol. 205, July 6, 1979, p. 85-87. 11 refs. Contract No. NAS2-9476.

Winds in the lower atmosphere of Venus, inferred from three-dimensional radio interferometric tracking of the descents of the Pioneer day and north probes, are predominantly easterly with speeds of about 1 M/sec near the surface, 50 at the bottom of the clouds, and more than 200 within the densest, middle cloud layer. Between about 25 and 55 km altitude the average flow was slanted equatorward, with superimposed wavelike motions and alternating layers of high and low shear. (Author)

**A79-40829 \*** Initial observations of the nightside ionosphere of Venus from Pioneer Venus Orbiter radio occultations. A. J. Kliore, I. R. Patel (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), A. F. Nagy, T. E. Cravens (Michigan, University, Ann Arbor, Mich.), and T. I. Gombosi (Michigan, University, Ann Arbor, Mich.). Magyar Tudományos Akadémia, Kozponti Fizikai Kutató Intézet, Budapest, Hungary). *Science*, vol. 205, July 6, 1979, p. 99-102. 10 refs. Contracts No. NAS7-100, No. NAS2-9130, Grant No. NGR-23-005-015.

Results of radio occultation measurements of electron density profiles of the nightside ionosphere of Venus at solar zenith angles from 90 to 164 deg, obtained from the Pioneer Venus Orbiter, are reported. Data were derived from closed-loop S- and X-band signals received by the Deep Space Network upon ionospheric entry and exit of the spacecraft. Nightside electron density profiles are found to be rather uniform in the solar zenith angle range of from 95 to 107 deg, with peak electron densities ranging from 23,000 to 40,000 cu cm, while between 110 and 164 deg, profiles exhibit a high degree of variability and peak electron densities vary from 7,600 to 31,800/cu cm. A possible mechanism for the maintenance of the nightside Venus ionosphere during the long Venus night, which is consistent with the observed spatial and temporal variability of deep

ionospheric electron density profiles, is proposed to be impact ionization by precipitating particles, although transport processes from the dayside may also be important. A.L.W.

**A79-40831 \*** Thermal structure and energy influx to the day- and nightside Venus ionosphere. W. C. Knudsen, K. L. Miller (Lockheed Research Laboratories, Palo Alto, Calif.), K. Spenger, V. Novak (Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung, Institut für physikalische Weltraumforschung, Freiburg im Breisgau, West Germany), R. C. Whitten (NASA, Ames Research Center, Moffett Field, Calif.), and J. R. Spreiter (Stanford University, Stanford, Calif.). *Science*, vol. 205, July 6, 1979, p. 105-107. 11 refs. Bundesministerium für Forschung und Technologie Contracts No. 01-DO-238; No. RV14-B28/73; Contract No. NAS2-9481.

The thermal structure of and energy influx to the dayside and nightside Venus ionosphere are discussed, based on data obtained by the Pioneer Venus spacecraft. Where the dayside ionosphere appears relatively constant in total ion concentration, ion and electron temperatures and ion composition below the ionopause, retarding potential analyzer measurements confirm the presence of strong spatial and temporal variations in nightside ion concentration. Ion temperatures on the nightside above 225 km are found to be larger by a factor of two or more than on the dayside, and comparable to electron temperatures on the day and night sides. Models of dayside and nightside ion temperatures consistent with observations require the heat input of 0.003 erg/sq cm sec and 0.005 erg/sq cm sec, respectively, to the ion gas to raise the ion temperature above that of the neutral gas, presumably by means of Joule heating. A.L.W.

**A79-40832 \*** Comparison of calculated and measured ion densities on the dayside of Venus. A. F. Nagy, T. E. Cravens, R. H. Chen (Michigan, University, Ann Arbor, Mich.), H. A. Taylor, Jr., L. H. Brace, and H. C. Brinton (NASA, Goddard Space Flight Center, Greenbelt, Md.). *Science*, vol. 205, July 6, 1979, p. 107-109. 21 refs. Contract No. NAS2-9130; Grant No. NGR-23-005-015.

Data from the Pioneer Venus ion mass spectrometers are compared with model calculations of the ion density distributions appropriate for daytime conditions. The model assumes diffusive equilibrium upper boundary conditions for the major ions (O<sub>2</sub>(+), O(+), CO<sub>2</sub>(+), He(+), and H(+)); the agreement between the calculated and measured gross behavior of these ions is reasonably good except for H(+), which may be influenced strongly by convective transport processes. The distributions of five minor ions (Cl(+), N(+), NO(+), CO(+), and N<sub>2</sub>(+)) are also calculated for the chemically controlled region (less than approximately 200 km); the agreements are, in general, poor, an indication that the present understanding of the Venus minor ion chemistry is still incomplete. (Author)

**A79-40834 \*** Absorption of whistler mode waves in the ionosphere of Venus. W. W. L. Taylor, F. L. Scarf (TRW Defense and Space Systems Group, Redondo Beach, Calif.), C. T. Russell (California, University, Los Angeles, Calif.), and L. H. Brace (NASA, Goddard Space Flight Center, Greenbelt, Md.). *Science*, vol. 205, July 6, 1979, p. 112-114. 13 refs. Contracts No. NAS2-9842; No. NAS2-8088; No. NAS2-9491.

It is shown that whistler mode waves from the ionosheath of Venus are absorbed by Landau damping at the dayside ionosphere boundary. This process heats the ionospheric electrons and it may provide an important energy input into the dayside ionosphere. Cyclotron damping of the waves does not occur in the same region. However, Landau damping of ionosheath waves is apparently not an important energy source in the nightside ionosphere. Impulsive events in the nightside ionosphere seem to fall into two classes: (1) lightning signals (near periaapsis) and (2) noise, which may be caused by gradient or current instabilities. (Author)

**A79-40835 \*** Initial Pioneer Venus magnetic field results - Nightside observations. C. T. Russell, R. C. Elphic, and J. A. Slavin

(California, University, Los Angeles, Calif.). *Science*, vol. 205, July 6, 1979, p. 114-116. 9 refs. Contract No. NAS2-9491.

Initial observations by the Pioneer Venus magnetometer on the nightside of Venus frequently reveal moderately strong fields from 20 to 30 nanoteslas. However, there is little evidence that these fields arise from an internal dynamo, since they are mainly horizontal and vary from orbit to orbit. Determining a precise upper limit to the intrinsic moment awaits further processing. This limit is expected to be much less than 10 to the twenty-second gauss-cubic second.

(Author)

**A79-40836 \*** Electron observations and ion flows from the Pioneer Venus Orbiter plasma analyzer experiment. D. S. Intriligator (Southern California, University, Los Angeles, Calif.), H. R. Collard, J. D. Mihalov, R. C. Whitten, and J. H. Wolfe (NASA, Ames Research Center, Space Science Div., Moffett Field, Calif.). *Science*, vol. 205, July 6, 1979, p. 116-119. 18 refs. Research supported by the University of Southern California; Contract No. NAS2-9478.

Additional plasma measurements in the vicinity of Venus are presented. It is shown that (1) there are three distinct plasma electron populations - solar wind electrons, ionosheath electrons, and nightside ionosphere electrons; (2) the plasma ion flow pattern in the ionosheath is consistent with deflected flow around a blunt obstacle; (3) the plasma ion flow velocities near the downstream wake may, at times, be consistent with the deflection of plasma into the tail, closing the solar wind cavity downstream from Venus at a relatively close distance (within 5 Venus radii) to the planet; (4) there is a separation between the inner boundary of the downstream ionosheath and the upper boundary of the nightside ionosphere; and (5) during the first 4.5 months in orbit the measured solar wind plasma speed continued to vary, showing a number of high-speed, but generally nonrecurrent, streams

(Author)

**A79-41292 \*** Pioneer 10 studies of interplanetary shocks at large heliocentric distances. J. D. Mihalov and J. H. Wolfe (NASA, Ames Research Center, Moffett Field, Calif.). *Geophysical Research Letters*, vol. 6, June 1979, p. 491-494. 26 refs.

Pioneer 10 Ames plasma analyzer data collected in the 6.1 to 12.6 AU range of heliocentric distances (November 1974 to April 1977) have been examined for interplanetary shock waves. Eighteen shock signatures have been identified, with four of these being of the reverse type and the remainder the forward type. Sonic Mach numbers in the range from 3 to 10 are estimated for these events.

(Author)

**A79-41293 \*** Plasma in the Jovian current sheet. C. K. Goertz, J. A. Van Allen, J. L. Parish (Iowa, University, Iowa City, Iowa), and A. W. Schardt (NASA, Goddard Space Flight Center, Greenbelt, Md.). *Geophysical Research Letters*, vol. 6, June 1979, p. 495-498. 10 refs. NSF Grant No. ATM-76-82739. Grants No. NGL-16-001-002, No. NGL-16-001-043. Contract No. NAS2-6553.

A large body of spectral data for protons with energies greater than 200 keV has been analyzed. It is concluded that the main body of plasma in the Jovian current sheet observed by Pioneer 10 on its outbound pass probably has an energy well below the lowest threshold of the Pioneer 10 detectors. This premise is examined using a semiempirical model of the magnetic field in the magnetodisk and simple magnetohydrodynamic theory. Results indicate that the dominant contribution to the plasma pressure in the region from 25 to 65 Jovian radii is from as yet unobserved protons (ions) with energies of the order of 0.1 to 10 keV.

C.K.D.

**A79-41325 \*** Far-infrared observations of optical emission-line stars - Evidence for extensive cool dust clouds. P. M. Harvey, H. A. Thronson, Jr. (Steward Observatory, Tucson, Ariz.), and I. Gatley (California Institute of Technology, Pasadena, Calif.). *Astrophysical Journal, Part 1*, vol. 231, July 1, 1979, p. 115-123. 50 refs. Grants No. NGR-03-002-390, No. NGR-05-002-281.

Far-infrared observations (40-160 microns) of eight optical emission-line stars are presented. Six of these stars, LkH-alpha 198, T

Tau, LkH-alpha 101, V380 Ori, R Mon, and MWC 1080, show substantially more far-infrared emission than would be expected on the basis of a blackbody extrapolation of their 10-20-micron fluxes. Additionally, in these cases, the far-infrared emission is shown to be spatially extended (greater than 40 arcsec). A simple model of the thermal emission from cool circumstellar dust (30-70 K) shows that these stars are surrounded by material left over from the star formation process; this result confirms the extreme youth of these stars. MWC 349 was detected at a level consistent with the expected free-free flux from its surrounding H II region, and RY Tau was not detected in the far-infrared; there is little circumstellar dust with temperatures of 20-100 K in these objects.

(Author)

**A79-41354 \*** Near-infrared observations of a new molecular feature in IRC + 10216. J. Krassner, L. L. Smith, and T. Hilgemann (Grumman Aerospace Corp., Bethpage, N.Y.). *Astrophysical Journal, Part 2 - Letters to the Editor*, vol. 231, July 1, 1979, p. L31-L35. 21 refs. Contract No. NAS2-9837.

This letter presents a spectrum of IRC + 10216 in the 3000-4400-kayser region at 9-kayser resolution. A molecular feature at 3400-3600 kaysers has been detected which is attributed to an unspecified N-H bonded molecule; the feature appears to be variable in phase with the infrared light curve. Evidence is given for temperature variations of the emitting dust shell in phase with the infrared light curve. The results suggest that the variability of the molecular feature is due to reversible dissociation of the responsible molecule, which could occur at the higher temperatures accompanying the maxima of the light curve.

(Author)

**A79-41520 \*** Improved limits on intergalactic intracluster H I in the Coma Cluster. J. C. Tarter (NASA, Ames Research Center, Moffett Field, Calif.) and M. C. H. Wright (California, University, Berkeley, Calif.). *Astronomy and Astrophysics*, vol. 76, no. 1, June 1979, p. 127-129. 7 refs.

New observations using the Arecibo telescope have failed to detect intergalactic intracluster H I in the Coma Cluster. This represents a factor of two improvements over our previously reported limit (Wright et al., 1974) and makes it less likely that the cluster can be dynamically bound by H I. The highly flattened, rapidly rotating, extremely dense, cold H I clouds permitted by the observations will not evaporate over the cluster lifetime, but violate global stability criteria and hence cannot provide the missing mass in the cluster.

(Author)

**A79-41771 \*** Numerical solution for supersonic flow near the trailing edge of a flat plate. D. Degani (Technion - Israel Institute of Technology, Haifa, Israel), M. Y. Hussaini, and B. S. Baldwin (NASA, Ames Research Center, Moffett Field, Calif., Technion - Israel Institute of Technology, Haifa, Israel). *Israel Conference on Mechanical Engineering, 12th, Technion - Israel Institute of Technology, Haifa, Israel, July 11, 12, 1978.* *Israel Journal of Technology*, vol. 16, no. 5-6, 1978, p. 208-215. 9 refs.

In the present study, problems of laminar and turbulent two-dimensional flow of a viscous compressible fluid near the trailing edge of a thin flat plate are considered. The complete set of Navier-Stokes equations is solved by the finite-difference method of MacCormack (MacCormack and Baldwin, 1975). It is an explicit, predictor-corrector, time-splitting method of second order accuracy. The computational mesh employed has sufficient resolution for all the characteristic lengths suggested by theory. In the laminar case, the present results are compared with the triple deck solution of Daniels (1974). This comparison indicates that the asymptotic triple deck theory for supersonic trailing edge flow is accurate within five percent for Reynolds numbers greater than 1000. In the turbulent case, the Prandtl-Van Driest-Clauser algebraic eddy viscosity model is used. The numerical results show that the region of upstream influence is approximately of the order of the boundary layer thickness. The solutions for skin-friction, pressure and wake centerline velocity are presented.

(Author)

**A79-43036 \*** An interpretation of Akasofu's substorm parameter. N. D'Angelo and C. K. Goertz (Iowa University, Iowa City, Iowa). *Planetary and Space Science*, vol. 27, July 1979, p. 1015-1018. 6 refs. NSF Grant No. ATM-76-82739; Grant No. NGL-16-001-043; Contract No. NAS2-6553.

The power flux into the magnetosphere from the solar wind is analyzed using the model of polar cap electric fields described by D'Angelo (1977). It is shown that the substorm parameter proposed by Akasofu (1978) to predict the probability of a substorm can be interpreted as the portion of the solar wind electromagnetic power flux which penetrates the magnetosphere at a given moment. C.K.D.

**A79-44216 \*** Characteristics of a CW water vapor laser at 118 and 28 microns. Y. Yasuoka (National Defense Academy, Yokosuka, Japan), P. Burlamacchi (CNR, Laboratorio di Elettronica Quantistica, Florence, Italy), S.-Y. Wang, and T. K. Gustafson (California, University, Berkeley, Calif.). *IEEE Journal of Quantum Electronics*, vol. QE-15, July 1979, p. 614-616. 8 refs. Grant No. NSG-2151.

The characteristics of a CW water vapor laser operating at 118 and 28 microns are reported. By monitoring the discharge current, helium gas pressure, and water vapor pressure, a criterion for optimum power output has been obtained. Peak powers of 6 and 114 mW are obtained, respectively, for the 118- and 28-micron lines for a 4.5-m discharge tube. (Author)

**A79-44624 \*** The radial evolution of the bulk properties of the solar wind. D. S. Intriligator (Southern California, University, Los Angeles, Calif.). In: International Cosmic Ray Conference, 15th, Plovdiv, Bulgaria, August 13-26, 1977, Conference Papers, Volume 11. (A79-44583 19-93) Sofia, B'lgarska Akademija na Naukite, 1978, p. 219-224. 11 refs. Research supported by the University of Southern California; Contract No. NAS2-7969; Grant No. NGR-05-018-181.

Simultaneous solar-wind proton data obtained at several heliocentric distances during radial alignments are compared. The radial variations associated with two high-speed streams in the solar wind are studied as examples of the radial evolution of the solar-wind speed distribution and of high-speed streams in the solar wind as observed in the ecliptic plane in 1973. Pioneer 11 data on high-speed streams in the solar wind observed at about 1.5 and 3.7 AU are compared with the corresponding high-speed-stream data obtained at earth. These analyses indicate that as these high-speed streams propagated to these extended heliocentric distances, there was an erosion of the highest speeds and a general narrowing of the speed distribution. These observations are consistent with the exchange of momentum in the solar wind between high-speed streams and low-speed streams as they propagate outward from the sun. (Author)

**A79-44625 \*** Evidence for a constant speed of shock propagation between 0.8 AU and 2.2 AU. D. S. Intriligator (Southern California, University, Los Angeles, Calif.). In: International Cosmic Ray Conference, 15th, Plovdiv, Bulgaria, August 13-26, 1977, Conference Papers, Volume 11. (A79-44583 19-93) Sofia, B'lgarska Akademija na Naukite, 1978, p. 225-229. 8 refs. Contract No. NAS2-7969; Grant No. NGR-05-018-181.

The results of preliminary analysis of the in situ observations of solar wind plasma and interplanetary magnetic field data are presented. It is indicated that two planetary shocks associated with the August 1972 solar events propagated at approximately constant speed between 0.8 AU and 2.2 AU. This result is contrary to some theoretical expectations and earlier reports for these events of a strong deceleration of these shocks with increasing heliocentric distance. One example given is the difference between observed shock speeds of 700 km/sec and the estimated speeds of 2200 km/sec for Pioneer 9 and 1000 km/sec for Pioneer 10. These higher average speeds associated with the propagation of the shocks from the sun to the spacecraft, therefore, imply an extremely strong deceleration closer to the sun (within 0.8 AU). M.E.P.

**A79-44637 \*** Interplanetary electrons - What is the strength of the Jupiter source. W. Fillius, W.-H. Ip, and P. Knickerbocker (California, University, La Jolla, Calif.). In: International Cosmic Ray Conference, 15th, Plovdiv, Bulgaria, August 13-26, 1977, Conference Papers, Volume 11. (A79-44583 19-93) Sofia, B'lgarska Akademija na Naukite, 1978, p. 334-339. 19 refs. Contract No. NAS2-6552; Grant No. NGR-05-009-081.

On the basis of conservative assumptions, a phenomenological approach is used to address the source strength of Jupiter for interplanetary electrons. It is estimated that Jupiter emits approximately 10 to the 24th - 10 to the 26th electrons per sec with energies in excess of 6 MeV, which sources may be compared with the population of approximately 3 x 10 to the 28th electrons of the same energy in the Jovian outer magnetosphere. It is concluded that Jupiter accelerates particles at a rate exceeding that of ordinary trapped particle dynamic processes. M.E.P.

**A79-45104 \*** Temperature and flow velocity of the interplanetary gases along solar radii. F. M. Wu and D. L. Judge (Scuthern California, Los Angeles, Calif.). *Astrophysical Journal, Part 1*, vol. 231, July 15, 1979, p. 594-605. 17 refs. Contract No. NAS2-5558.

The velocity distributions along solar radii for hydrogen and helium in interplanetary space are calculated by using the Danby-Camm formula modified with a loss function. From these distributions the radial temperature and radial flow velocity of the interplanetary gases are determined. The effects of solar gravitation and ionization loss, due to charge exchange and photoionization, on the gas temperature and velocity are described. (Author)

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**A79-45252 \*** An implicit factored scheme for the compressible Navier-Stokes equations. II - The numerical ODE connection. R. M. Boisjoly and G. R. F. Warming (NASA, Ames Research Center, Computational Fluid Dynamics Branch, Moffett Field, Calif.). In: Computational Fluid Dynamics Conference, Williamsburg, Va., July 23-27, 1979, Collection of Technical Papers. (A79-45251 19-34) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 1-14. 26 refs. (AIAA 79-1446)

An attempt is made to establish a connection between linear multistep methods for applications to ordinary differential equations and their extension (by approximate factorization) to alternating direction implicit methods for partial differential equations. An earlier implicit factored scheme for the compressible Navier-Stokes equations is generalized by innovations that (1) increase the class of temporal difference schemes to include all linear multistep methods, (2) optimize the class of unconditionally stable factored schemes by a new choice of unknown variable, and (3) improve the computational efficiency by the introduction of quasi-one-leg methods. B.J.

**A79-45261 \*** A fast, conservative algorithm for solving the transonic full-potential equation. T. L. Holst (NASA, Ames Research Center, Applied Computational Aerodynamics Branch, Moffett Field, Calif.). In: Computational Fluid Dynamics Conference, Williamsburg, Va., July 23-25, 1979, Collection of Technical Papers. (A79-45251 19-34) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 109-121. 23 refs. (AIAA 79-1456)

A fast, fully implicit approximate factorization (AF) algorithm designed to solve the conservative transonic full-potential equation in either two or three dimensions is described. The algorithm uses an upwind bias of the density coefficient for stability in supersonic regions. This provides an effective upwind difference of the streamwise terms for any orientation of the velocity vector (i.e., 'rotated differencing'), and thereby greatly enhances the reliability of the present algorithm. A numerical transformation is used to establish an arbitrary body-fitted finite-difference mesh. Computed results for both airfoils and simplified wings demonstrate substantial improvement in convergence speed for the new algorithm relative to standard successive-line overrelaxation algorithms. (Author)

**A79-45269 \* #** A two-dimensional unsteady Euler-equation solver for flow regions with arbitrary boundaries. R. G. Hindman (NASA, Ames Research Center, Moffett Field, Calif.; Iowa State University of Science and Technology, Ames, Iowa), P. Kutler (NASA, Ames Research Center, Computational Fluid Dynamics Branch, Moffett Field, Calif.), and D. Anderson (Iowa State University of Science and Technology, Ames, Iowa). In: Computational Fluid Dynamics Conference, Williamsburg, Va., July 23-25, 1979, Collection of Technical Papers. (A79-45251 19-34) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 204-217. 39 refs. Research supported by Iowa State University of Science and Technology and NASA. (AIAA 79-1465)

A new technique is described for solving supersonic fluid dynamic problems containing multiple regions of continuous flow, each bounded by a permeable or impermeable surface. Region boundaries are, in general, arbitrarily shaped and time dependent. Discretization of such a region for solution by conventional finite difference procedures is accomplished using an elliptic solver which alleviates the dependence on a particular base coordinate system. Multiple regions are coupled together through the boundary conditions. The technique has been applied to a variety of problems including the shock diffraction and pointed wedge with detached bow shock. (Author)

**A79-45456 \*** Convection and lunar thermal history. P. Cassen, R. T. Reynolds, F. Graziani, A. Summers, J. McEllis, and L. Blalock (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). (*Lunar and Planetary Institute and NASA, Workshop on Solid Convection in the Terrestrial Planets, Moffett Field, Calif., Dec. 12, 13, 1977.*) *Physics of the Earth and Planetary Interiors*, vol. 19, June 1979, p. 183-196. 50 refs.

The effects of solid interior convection on the thermal history of the moon are examined. Convective models of lunar evolution are calculated to demonstrate the influence of various viscosities, radioactive heat source distributions and initial temperature profiles and tested by means of a thermal history simulation code. Results indicate that solid convection does not necessarily produce a quasi-steady thermal balance between heat sources and surface losses. The state of the lithosphere is found to be sensitive to the efficiency of heat source redistribution, while that of the convecting interior depends primarily on rheology. Interior viscosities of 10 to the 21st to 10 to the 22nd cm/sec are obtained, along with a central temperature above 1100 C. It is suggested that mare flooding could have been the result of magma production by pressure release melting in the upwelling region of convection cells. A.L.W.

**A79-45569 \*** An infrared study of the NGC 7538 region. M. W. Werner, E. E. Becklin, I. Gatley, K. Matthews, G. Neugebauer (California Institute of Technology; Hale Observatories, Pasadena, Calif.), and C. G. Wynn-Williams (Mullard Radio Astronomy Observatory, Cambridge, England). *Royal Astronomical Society, Monthly Notices*, vol. 188, Aug. 1979, p. 463-479. 40 refs. NSF Grant No. AST-75-18555-A2; Grants No. NGR-05-002-281; No. NGL-05-002-207.

Infrared observations of the NGC 7538 region at wavelengths from 1 micron to 1 mm are presented and analyzed with the aim of understanding both the large-scale structure of this region of current star formation and the properties of the individual compact objects within it. At far-infrared wavelengths (25-130 microns), emission is seen from the visible H II region, from the vicinity of the previously known maser source and dust-embedded compact HII regions, and from a new region called NGC 7538(E). Coincident with NGC 7538(E) are a point-like 1-25 micron infrared source, NGC 7538-IRS9, which probably provides the power for the far-infrared emission, and an extended source of 2.2 micron emission which appears to be an infrared reflection nebula. The compact H II regions, the maser sources and IRS9 are located within a dense molecular cloud at the edge of the optical H II region. This cloud, which has a mass of approximately 9000 solar masses, is detected in emission at 1 mm. The NGC 7538 region appears to contain examples of different stages in the formation of massive stars; it is suggested that the center of star formation is moving systematically to the southeast in this region. (Author)

**A79-45882 \* #** Propagation of a Forbush decrease in cosmic ray intensity to 15.9 AU. J. A. Van Allen (Iowa University, Iowa City, Iowa). *Geophysical Research Letters*, vol. 6, July 1979, p. 566-568. 9 refs. Navy-supported research; Contract No. NAS2-6553.

By observation of the large Forbush decrease in cosmic-ray intensity of April-May 1978 at heliocentric radial distances of 1.01, 6.97, and 15.91 AU, it is found that the causative magnetized plasma cloud moved outward from the sun at an apparent radial speed of about 960 km/s, independent of radial distance over this range. Recovery from the impulsive decrease in intensity was markedly slower at the larger distances. On the basis of this fact and other considerations, several tentative suggestions are made as to the large-scale nature of Forbush decreases and their relationship to the 11-year solar modulation of galactic cosmic-ray intensity. (Author)

**A79-45887 \*** Evidence for earth magnetospheric tail associated phenomena at 3100 R sub E. D. S. Intriligator (Southern California, University, Los Angeles, Calif.), H. R. Collard, J. D. Mihalov, J. H. Wolfe (NASA, Ames Research Center, Moffett Field, Calif.), and O. L. Vasberg (Akademii Nauk SSSR, Institut Kosmicheskikh Issledovanii, Moscow, USSR). *Geophysical Research Letters*, vol. 6, July 1979, p. 585-588. 12 refs. Grant No. NGR-05-018-181.

Examination of Pioneer 7 NASA Ames Research Center plasma analyzer data obtained in February 1977 at about 3100 earth radii, downstream from earth in the vicinity of the expected extended geomagnetic tail indicate that tail-related phenomena may have been observed. These observations are characterized by intermittent intervals of extremely low levels of plasma ion flux. Corresponding Prognoz 5 Space Research Institute plasma ion data obtained in the vicinity of earth indicate typical solar-wind flux levels and a relatively steady character of the solar wind during this time. These recent Pioneer 7 observations in the vicinity of the expected geomagnetic tail at about 3100 earth radii are consistent with earlier Pioneer 7 observations in September 1966 at about 1000 earth radii and Pioneer 8 observations in January 1968 at about 500 earth radii and represent the most extended positive observational information of the extended nature of the geomagnetic tail. These measurements suggest that at times Jupiter's magnetosphere may have tail-associated phenomena extending to distances of about 10 AU downstream from the planet. These measurements also raise the possibility that at times comets may have tail-associated phenomena extending downstream from the visible tail. (Author)

**A79-45891 \*** Sulfur dioxide in the Venus atmosphere - Distribution and implications. L. W. Esposito, J. R. Winick, and A. I. Stewart (Colorado, University, Boulder, Colo.). *Geophysical Research Letters*, vol. 6, July 1979, p. 601-604. 19 refs. Contracts No. NAS2-8816; No. NAS2-9477.

The Pioneer Venus Orbiter ultraviolet spectrometer sees variable disk brightness features similar to the well-known 'UV markings' seen at longer wavelengths. The bright features are consistent with a homogeneous cloud of H<sub>2</sub>SO<sub>4</sub> aerosols. The darker features show the presence of a broad-band absorber, which is at some depth in the cloud layer. Additional contrast arises from SO<sub>2</sub> absorption. The observed strength of the SO<sub>2</sub> absorption as a function of wavelength rules out a uniform mixing ratio for the SO<sub>2</sub>. The data are well fitted by an inhomogeneous light scattering model in which the SO<sub>2</sub> scale height is one-fifth of the CO<sub>2</sub> scale height, and the mixing ratio of SO<sub>2</sub> at 40 mb is 10 to the -7th. A model of the oxidation of sulfur dioxide in the upper cloud reproduces the observed vertical distribution of SO<sub>2</sub> and indicates that SO<sub>2</sub> alone is sufficient to produce the observed amount of H<sub>2</sub>SO<sub>4</sub> in this region. (Author)

**A79-45940 \* #** Magnetometer data errors and lunar induction studies. W. D. Daily (Eyring Research Institute, Provo, Utah) and P. Dyal (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Geophysical Research*, vol. 84, July 1, 1979, p. 3313-3326. 20 refs. Grant No. NGR-2082.

Errors in lunar magnetic field data acquired by the Apollo 12, 15 and 16 surface magnetometers and the two magnetometers on board the lunar-orbiting Explorer 35 satellite are examined and the implications of these errors for investigations of lunar magnetic induction are discussed. It is found that during the first four lunations of Apollo 12 magnetometer operation, the gain and offset differences with respect to the Explorer magnetometers are 1 to 2% and 0.5 gamma, respectively, with close agreement between the two Explorer magnetometers, but increase up to 60% and 1 gamma by the eighth lunation, accompanied by the degradation of the agreement between the orbital instruments, which indicates the malfunction of the Explorer instruments by the fifth lunation. An additional anomaly, associated with the exit of the spacecraft from the lunar shadow is also found, along with the nonlinear field response of the Apollo 15 magnetometer near zero field and small magnitude noise in the surface magnetometers. The effects of gain errors on electrical conductivity determinations are estimated and previously published lunar magnetic permeability results are adjusted to account for magnetometer gain uncertainties, yielding a permeability of  $1.012 \pm 0.011$ . A.L.W.

**A79-46414 \* # Physics of the solar wind for the 1975-1978 IUG Quadrennial Report.** A. Barnes (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). *Reviews of Geophysics and Space Physics*, vol. 17, June 1979, p. 596-610. 380 refs.

The paper surveys topics related to the origin, expansion, and acceleration of the solar wind and the plasma physics of the interplanetary medium. The study of the relationship between coronal holes and solar-wind streams, and the associated revision of ideas about solar wind acceleration and heating are reviewed. In addition, topics of hydromagnetic waves and turbulence, and interplanetary electrons, as items of particular importance during the past quadrennium, are discussed. While the research discussed was concerned with data taken near solar minimum, further solar-wind studies will concentrate on observations from the rising and maximum phases of the solar cycle. V.T.

**A79-46424 \* The dynamics of the Jovian magnetosphere.** C. K. Goertz and M. F. Thomsen (Iowa University, Iowa City, Iowa). *Reviews of Geophysics and Space Physics*, vol. 17, June 1979, p. 731-743. 200 refs. NSF Grant No. AMT-76-82739; Contract No. NAS2-6553.

The current status of the understanding of the dynamics of Jupiter's magnetosphere is reviewed. A brief summary is presented of the concepts and processes which were identified as being of probable importance by pre-Pioneer 10 and 11 work (both theoretical and observational). The insights provided by the in situ Pioneer flights are then discussed. The Jovian magnetosphere consists of several relatively distinct regions: the inner magnetosphere, the intermediate magnetosphere, the outer magnetosphere, a transition region just inside the magnetopause, and the magnetosheath. The basic particle and magnetic field characteristics of these regions are summarized, and the dynamical processes which are currently thought to be significant in each of them are reviewed. Finally, some outstanding questions and problems are identified for future treatment based on Pioneer data or on data from the upcoming Voyager and Galileo missions. (Author)

**A79-46586 \* Equivalence of airborne and ground-acquired wheat canopy temperatures.** J. P. Millard (NASA, Ames Research Center, Moffett Field, Calif.), J. L. Hatfield (California University, Davis, Calif.), and R. C. Goettelman (LFE Corp., Richmond, Calif.). *Remote Sensing of Environment*, vol. 8, Aug. 1979, p. 273-275. 5 refs.

The relationship between airborne and ground-based measurements of soil and crop canopy temperatures is investigated for a partial crop canopy. Daily ground-based measurements using a wide-field-of-view radiometer oriented towards the nadir at a height of 1.5 m and airborne thermal imagery at two-week intervals were obtained throughout the entire growing season of a stand of wheat.

When corrected for atmospheric effects, the airborne measurements were found to be virtually identical to ground-based measurements, with a regression line slope of 0.985, a standard deviation of 1.8 C and a correlation coefficient of 0.97. A.L.W.

**A79-46685 \* # Topology of two-dimensional and three-dimensional separated flows.** M. Tobak and D. J. Peake (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1480*. 30 p. 36 refs.

It is shown that topology rules can define a small number of singular points on an aerodynamic surface and in the flow which can be combined in various ways to create the structures and characterize the physical mechanisms of three-dimensional separated flows. This topological development is based on the hypothesis that vector fields of skin-friction lines and external streamlines remain continuous. Among examples treated are the lee-side separated flows about slender bodies at angle of attack with symmetric or asymmetric wake structures; about a protuberance normal to a wall; and over a rearward-facing axisymmetric step. B.J.

**A79-46696 \* # Effect of Mach number and Reynolds number on a normal shock-wave/turbulent boundary-layer interaction.** G. G. Mateer and J. R. Viegas (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1502*. 9 p. 15 refs.

Experimental values of wall pressure and skin friction have been obtained for Mach numbers from 1.32 to 1.48 and for Reynolds numbers from  $8.5 \times 10^6$  to the 6th to  $225 \times 10^6$  to the 6th. Increasing the Mach number reduces the wall shear and promotes incipient separation. Reynolds number variations have little effect except at the lowest value where the flow abruptly approaches separation. Comparisons are made with solutions to the time-dependent, Reynolds-averaged, Navier-Stokes equations incorporating a two-equation, Wilcox-Rubesin turbulence model. The computations are in agreement with the experimental results. Additional numerical results indicated that the wind-tunnel walls constrained the flow and suppressed the formation of a separation bubble at the shock wave. (Author)

**A79-46697 \* # Trailing-edge flows at high Reynolds number.** P. R. Viswanath, J. W. Cleary, H. L. Seegmiller, and C. C. Horstman (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1503*. 17 p. 22 refs.

An investigation of trailing-edge flows at high Reynolds number and subsonic Mach numbers is presented. Symmetric and asymmetric trailing-edge flows are studied, each flow having pressure gradient regions upstream of the trailing edge similar to an airfoil. Measurements include model surface pressures, mean velocity, turbulent shear stress, and turbulent kinetic energy profiles in the trailing-edge and near-wake regions. Comparisons of the symmetric data with numerical solutions of boundary layer as well as Navier-Stokes equations employing two different turbulence models show increasing effects on viscous interactions as the Mach number increases. Both turbulence models yielded solutions of the mean flow of comparable quality. The experimental results of the asymmetric case are discussed. (Author)

**A79-46723 \* # Numerical solution of supersonic laminar flow over an inclined body of revolution.** C. M. Hung (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1547*. 11 p. 19 refs.

A mixed explicit-implicit scheme is used to solve the time-dependent thin-layer approximation of the Navier-Stokes equations

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for a supersonic laminar flow over an inclined body of revolution. Test cases for Mach 2.8 flow over a cylinder with 15 deg flare angle at angles of attack of 0, 1, and 4 deg are calculated. Good agreement is obtained between the present computed results and experimental measurements of surface pressure. A pair of vortices on the leeward and a peak in the normal force distribution near the flared juncture are predicted; the role of circumferential communication is discussed.

(Author)

**A79-47358 \*** Energetic electrons in Jupiter's dawn magnetodisc. J. A. van Allen (Iowa University, Iowa City, Iowa). *Geophysical Research Letters*, vol. 6, Apr. 1979, p. 309-312. 10 refs. Navy-supported research; Contract No. NAS2-6553.

The paper presents and analyzes absolute energy density data on electrons from the University of Iowa instrument on Pioneer 10 for one example of a plasma sheet traversal in Jupiter's dawn magnetodisc on 6-7 December 1973. The absolute integral omnidirectional intensity spectrum of electrons is based on a full and accurate reduction of the counting rate data. The main finding is that electrons of energy greater than 0.060 MeV provide only about 3% of the charged particle pressure required to explain the observed depression in the magnetic field at the center of the plasma sheet, in spite of the fact that the intensity of such electrons is well correlated with the depression of the magnetic pressure throughout the sheet.

S.D.

**A79-47453 \*** Measurement of turbulent fluctuations in high-speed flows using hot wires and hot films. M. Acharya (NASA, Ames Research Center, Moffett Field, Calif.). *Review of Scientific Instruments*, vol. 50, Aug. 1979, p. 952-957. 11 refs.

The paper examines the dynamic calibrations of the hot film and modified hot-wire probes with a view to assess their suitability for use in experiments for the measurement of turbulent fluctuations in compressible boundary-layer flows. Results are presented of tests on some sensors in both subsonic and supersonic boundary-layer flows. A simple technique is presented for determining dynamic calibration correction factors for the sensitivities involved.

S.D.

**A79-47513 \*** Intensities and half-widths at different temperatures for the 201/III/-000 band of CO<sub>2</sub> at 4854 per cm. F. P. J. Valero, C. B. Suarez, and R. W. Boese (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 22, July 1979, p. 93-99. 16 refs.

**A79-47514 \*** Calculation of radiative properties of nonequilibrium hydrogen plasma. C. Park (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 22, July 1979, p. 101-112. 24 refs.

A computer program called NEQRAP is described that calculates the radiative properties of nonequilibrium ionized hydrogen. From the given electron temperature, electron density, and atom density values (which do not necessarily satisfy the equilibrium relationship) and intensities of incident radiation, the non-Boltzmann populations of electronic states are computed by solving the equation of quasi-steady-state population distribution. Emission and absorption coefficients are determined as functions of wavelength by invoking the principle of detailed balance between the upper and lower states of each radiative transition. Radiative transport through the medium is computed assuming a one-dimensional uniform slab. The rate of ionic reaction is also computed. When used on a sample case, the program shows that there is a large difference between the calculated intensities of radiation emitted by a bulk of equilibrium and nonequilibrium hydrogen. The accuracy of the program is estimated to be better than 10%.

(Author)

**A79-47967 \*** On reliable control system designs with and without feedback reconfigurations. J. D. Birdwell (Tennessee University, Knoxville, Tenn.), D. A. Castanon, and M. Athans (MIT, Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 419-426. 14 refs. Research supported by the Fannie and John Herz Foundation; Grants No. NGL-22-009-124; No. AF-AFOSR-77-3281.

This paper contains an overview of a theoretical framework for the design of reliable multivariable control systems, with special emphasis on actuator failures and necessary actuator redundancy levels. Using a linear model of the system, with Markovian failure probabilities and quadratic performance index, an optimal stochastic control problem is posed and solved. The solution requires the iteration of a set of highly coupled Riccati-like matrix difference equations; if these converge one has a reliable design; if they diverge, the design is unreliable, and the system design cannot be stabilized. In addition, it is shown that the existence of a stabilizing constant feedback gain and the reliability of its implementation is equivalent to the convergence properties of a set of coupled Riccati-like matrix difference equations. In summary, these results can be used for offline studies relating the open loop dynamics, required performance, actuator mean time to failure, and functional or identical actuator redundancy, with and without feedback gain reconfiguration strategies.

(Author)

**A79-47977 \*** Binary classification of real sequences by discrete-time systems. M. E. Kaliski (Northeastern University, Boston, Mass.) and T. L. Johnson (MIT, Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. (A79-47930 21-63) New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 772, 773. Grants No. AF-AFOSR-77-3281; No. NGL-22-009-124.

This paper considers a novel approach to coding or classifying sequences of real numbers through the use of (generally nonlinear) finite-dimensional discrete-time systems. This approach involves a finite-dimensional discrete-time system (which we call a real acceptor) in cascade with a threshold type device (which we call a discriminator). The proposed classification scheme and the exact nature of the classification problem are described, along with two examples illustrating its applicability. Suggested approaches for further research are given.

(Author)

**A79-48086 \*** A numerical model of the Martian polar cap winds. R. M. Haberle, C. B. Leovy (Washington University, Seattle, Wash.), and J. B. Pollack (NASA, Ames Research Center, Theoretical Studies Branch, Moffett Field, Calif.). *Icarus*, vol. 39, Aug. 1979, p. 151-183. 42 refs. Grants No. NSG-2047; No. NSG-7085.

An investigation of the Martian polar cap winds and their response to a variety of factors is carried out by numerical experiments based on a zonally symmetric primitive equation model. The seasonal thermal forcing, mass exchange between polar caps and atmosphere, large-scale topography, and polar cap size are discussed, noting that topography has a small effect, but the circulation intensity increases with cap size. The model results show that surface winds near the edge of a retreating polar cap are enhanced, and that the surficial wind indicators near the south pole are formed during spring and those near the north pole during winter. It is suggested that the high-latitude dune fields in the northern hemisphere are formed when the terrain is covered by frost, and that the saltating particles are 'snowflakes' which formed by the mechanism proposed by Pollack (1976). The model results for the winter simulation compare favorably with general circulation model (GCM) calculations.

A.T.

**A79-48252 \*** Calculated rate constants for the reaction ClO + O yields Cl + O<sub>2</sub> between 220 and 1000 K. R. L. Jaffe (NASA, Ames Research Center, Moffett Field, Calif.). *Chemical Physics*, vol. 40, July 1, 1979, p. 185-206. 72 refs.

**A79-48370 \*** Theory of the large-amplitude plane magneto-acoustic wave propagating transverse to the magnetic field in a hot collisionless plasma. A. Barnes (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). *Journal of Geophysical Research*, vol. 84, Aug. 1, 1979, p. 4459-4462. 22 refs.

An exact solution of the kinetic and electromagnetic equations for a large-amplitude plane magnetoacoustic wave propagating transverse to the magnetic field in a hot collisionless plasma is presented. The solution gives simple relations among the magnetic-field strength, density, stress tensor, and plasma velocity, all of which are measurable in the interplanetary plasma. These relations are independent of the electron and ion velocity distributions, subject to certain restrictions on 'high-velocity tails.' The magnetic field of the wave is linearly polarized. The wave steepens to form a shock much as the analogous waves of MHD theory do. (Author)

**A79-48526 \*** Soil transport by winds on Mars. B. R. White (California, University, Davis, Calif.). *Journal of Geophysical Research*, vol. 84, Aug. 10, 1979, p. 4643-4651. 17 refs. Grant No. NCA2-OR180-605.

Results of low-pressure wind tunnel testing and theoretical considerations are used to estimate the eolian transport of surface material on Mars. Saltation on Mars, equations of particle motion, computational results, and analytical determination of surface material movement are considered. A semiempirical formula is developed for estimating the total amount of surface material moving in eolian saltation, surface traction, and suspension. Numerical solutions of the equations of motion for particle trajectories on the surface of Mars are presented. The ratio of final particle speed to the particle threshold friction speed is found to be several times that of saltation on earth. S.D.

**A79-49415 \*** An accurate method for two-point boundary value problems. J. D. A. Walker (Lehigh University, Bethlehem, Pa.) and G. G. Weigand (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). *International Journal for Numerical Methods in Engineering*, vol. 14, no. 9, 1979, p. 1335-1346. 11 refs. Grant No. NSG-2135.

A second-order method for solving two-point boundary value problems on a uniform mesh is presented where the local truncation error is obtained for use with the deferred correction process. In this simple finite difference method the tridiagonal nature of the classical method is preserved but the magnitude of each term in the truncation error is reduced by a factor of two. The method is applied to a number of linear and nonlinear problems and it is shown to produce more accurate results than either the classical method or the technique proposed by Keller (1969). C.F.W.

**A79-49623 \*** Upper limits on argon isotope abundances in the Venus thermosphere. K. Mauersberger, U. von Zahn (Bonn, Universität, Bonn, West Germany), and D. Kräckowsky (Max-Planck-Institut für Kernphysik, Heidelberg, West Germany). *Geophysical Research Letters*, vol. 6, Aug. 1979, p. 671-674. 14 refs. Bundesministerium für Forschung und Technologie Contract No. WRK-275; Contract No. NAS2-8812.

On December 9, 1978 the neutral gas mass spectrometer aboard the NASA Pioneer Venus multiprobe bus has measured density, composition, and temperature of the Venus dayside thermosphere. There was no positive identification of argon down to the lowest measuring altitude of 130 km. For the altitude level of 135 km the following upper limits for the number densities of argon isotopes were derived: n(Ar-36) less than 1.3 times 10 to the 6th power per cu cm and n(Ar-40) less than 2.8 times 10 to the 6th power per cu cm. From our upper atmosphere observations we infer for the troposphere of Venus the following upper limits for the mixing ratios: n(Ar-36)/total number density less than 9 times 10 to the minus 6th power and n(Ar-40)/total number density less than 20 times 10 to the minus 6th power. (Author)

**A79-49739 \*** An ab initio investigation of the structure, vibrational frequencies, and intensities of HO<sub>2</sub> and HOCl. A. Komornicki and R. L. Jaffe (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Chemical Physics*, vol. 71, Sept. 1, 1979, p. 2150-2155. 72 refs.

The infrared spectral intensities for HOCl and HO<sub>2</sub> have been calculated using a new ab initio technique. Theoretical results for the geometries, vibrational frequencies, and the dipole moments of these species are also reported. All of the calculations were performed at the SCF level using near Hartree-Fock quality basis sets. The results for the molecular geometries and the vibrational frequencies are in good agreement with available experimental data. It is believed that the computed intensities are accurate to at least 50%. The results should be helpful in attempts to determine the stratospheric abundance of HOCl and HO<sub>2</sub> by in situ infrared spectroscopic measurements. (Author)

**A79-50014 \*** An improved synthesis of 2,4,8,10-tetraoxaspiro[5.5/undecane/pentaerythritol diformal]. A. C. Poshkus (NASA, Ames Research Center, Chemical Research Projects Office, Moffett Field, Calif.). *Journal of Heterocyclic Chemistry*, vol. 16, July 1979, p. 1075, 1076. 12 refs.

It is found that high yields of pentaerythritol diformal can be prepared in less than 10 minutes by heating a stirred mixture of pentaerythritol with a slight excess of paraformaldehyde up to about 120°C in the presence of catalytic amounts of acid, but without any solvents or with only a small amount of water. The reaction was carried out in two stages: first by preparing the monoformal with a molar equivalent of paraformaldehyde in about five minutes, and then, after cooling to about 70°C, adding the remainder of paraformaldehyde in 1% excess, and heating to about 120°C for a total heating time of 10 minutes. V.T.

**A79-50015 \*** The study of 'microsurfaces' using thermal desorption spectroscopy. M. E. Thomas, H. Poppe, and G. M. Pound (NASA/Stanford Joint Institute for Surface and Microstructural Research, Moffett Field, Calif.). (*Institute of Physics, International Congress on Thin Films, 4th, Loughborough, England, Sept. 11-15, 1978. Thin Solid Films*, vol. 58, 1979, p. 273-279. 5 refs. NSF Grant No. DMR-77-05958; Grant No. NCA2-OR745-711).

The use of a newly combined ultrahigh vacuum technique for studying continuous and particulate evaporated thin films using thermal desorption spectroscopy (TDS), transmission electron microscopy (TEM), and transmission electron diffraction (TED) is discussed. It is shown that (1) CO thermal desorption energies of epitaxially deposited (111) Ni and (111) Pd surfaces agree perfectly with previously published data on bulk (111) single crystal, (2) contamination and surface structural differences can be detected using TDS as a surface probe and TEM as a complementary technique, and (3) CO desorption signals from deposited metal coverages of one-thousandth of a monolayer should be detectable. These results indicate that the chemisorption properties of supported 'microsurfaces' of metals can now be investigated with very high sensitivity. The combined use of TDS and TEM-TED experimental methods is a very powerful technique for fundamental studies in basic thin film physics and in catalysis. (Author)

**A79-50016 \*** An improved synthesis of 1,3:2,4:5,6-Triethylene sorbitol and 1,3:2,5:4,6-Triethylene mannitol. A. C. Poshkus (NASA, Ames Research Center, Chemical Research Projects Office, Moffett Field, Calif.). *Journal of Organic Chemistry*, vol. 44, no. 15, 1979, p. 2794, 2795. 8 refs.

**A79-50597 \*** Electrical hazards posed by graphite fibers. G. S. Springer, S. A. Mashtizadeh, and R. B. Keller (Michigan, University, Ann Arbor, Mich.). *Journal of Composite Materials*, vol. 13, July 1979, p. 225-231. 6 refs. USAF-supported research; Grant No. NSG-2333.

The direct electrical resistance and the electrical contact resistance of graphite fibers released from both burned and unburned Fiberite T300/1034 composite were measured. The voltage at which arcing occurs due to fibers settling on electrical conductors was also determined. On the basis of results obtained, an assessment was made of the hazards posed by graphite fibers to electrical equipment.

(Author)

**A79-51043 \*** Biomagnetic instrumentation and measurement. E. J. Iufer (NASA, Ames Research Center, Moffett Field, Calif.). In: Noninvasive cardiovascular measurements. (A79-51026 23-54) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 175-180. 16 refs.

The instruments and techniques of biomagnetic measurement have progressed greatly in the past 15 years and are now of a quality appropriate to clinical applications. The paper reports on recent developments in the design and application of SQUID (Superconducting Quantum Interference Device) magnetometers to biomagnetic measurement. The discussion covers biomagnetic field levels, magnetocardiography, magnetic susceptibility plethysmography, ambient noise and sensor types, principles of operation of a SQUID magnetometer, and laboratory techniques. Of the many promising applications of noninvasive biomagnetic measurement, magnetocardiography is the most advanced and the most likely to find clinical application in the near future. S.D.

**A79-51121 \*** An experimental determination of the cross section of the Swings band system of C3. D. M. Cooper (NASA, Ames Research Center, Moffett Field, Calif.) and J. J. Jones (NASA, Langley Research Center, Hampton, Va.). *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 22, Aug. 1979, p. 201-208. 26 refs.

The spectral absorption cross section of the Swings band of C3 was determined from measurements behind incident shock waves that heated a gas mixture of argon and acetylene. These measurements spanned the spectral region between 300 and 540 nm, and were obtained at temperatures between 3200 and 4000 K. An electronic oscillator strength of 0.033 was deduced from the measurements.

(Author)

**A79-51236 \*** On the interweaving of partial cross sections of different parity. P. L. Devries and T. F. George (Rochester, University, Rochester, N.Y.). *Chemical Physics Letters*, vol. 63, May 15, 1979, p. 240-242. NSF Grant No. CHE-77-27826; Contract No. F49620-78-C-0005; Grant No. NsG-2198.

Partial cross sections of definite parity, calculated for electronic-rotational energy transfer in the F + H<sub>2</sub> collision system, interweave with increasing total angular momentum J. An explanation, in terms of diabatic curve crossings induced by the centrifugal potential in the body-fixed coordinate system, predicts the interweaving to occur only in systems having half-integer J.

(Author)

**A79-51237 \*** The utilization of abelian point group symmetry in the graphical unitary group approach to the calculation of correlated electronic wavefunctions. I. Shavitt (Battelle Columbus Laboratories, Ohio State University, Columbus, Ohio). *Chemical Physics Letters*, vol. 63, June 1, 1979, p. 421-427. 20 refs. Grant No. NsG-2231.

A procedure is described for the utilization of abelian point group symmetry in the graphical unitary group approach (GUGA) to calculations of correlated electronic wavefunctions. The procedure is based on a recursively computed set of symmetry dependent counting indices, and results in the separate numbering, without gaps, of the Gelfand states (configuration functions) belonging to each symmetry species.

(Author)

**A79-51496 \*** Is there liquid water on Europa. P. Cassen, R. T. Reynolds (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.), and S. J. Peale (California, University, Santa Barbara, Calif.). *Geophysical Research Letters*, vol. 6, Sept. 1979, p. 731-734. 21 refs. Grants No. NGR-05-010-062; No. NCA2-OR680-805.

It is possible that tidal dissipation in an ice crust on Europa preserved a liquid water layer beneath it, provided that the three-body orbital resonance for Io, Europa, and Ganymede is ancient. The liquid water layer could be a continuing source of the observed surface frost. If Europa's water mantle were ever completely frozen, heating by tidal dissipation would not exceed that produced by radioactive elements, and the mantle would remain frozen.

(Author)

**A79-51498 \*** Venus tectonics - Another earth or another Mars. G. E. McGill (Massachusetts, University, Amherst, Mass.). *Geophysical Research Letters*, vol. 6, Sept. 1979, p. 739-741. 26 refs. Contract No. NAS2-9129; Grant No. NGR-22-010-076.

The paper reexamines the evidence on the intensity of Venusian tectonic/volcanic activity and suggests alternate hypotheses. Three major questions are discussed: (1) whether the presence of large, presumably primordial craters on Venus requires an intensity of tectonic/volcanic activity significantly less than on earth, (2) what thicknesses of lithosphere are implied for reasonable models of temperature and volatile content of the upper mantle of Venus, and (3) can the recently obtained Ar-40 content of the Venus lower atmosphere help define the relative tectonic/volcanic activities of Venus and earth. It was shown that the abundance of Ar-40 in the Venus atmosphere lies between the earth value and one-tenth of the earth value, and since erosional liberation of Ar-40 on Venus will be inefficient, this range for Ar-40 abundance indicates an active tectonic history. It is concluded that the presence of craters and possible mantle dryness does not restrict Venus tectonics to a Mars-like model, and an earth-like model is equally probable. A.T.

**A79-51695 \*** The structure of small, vapor-deposited particles. II - Experimental study of particles with hexagonal profile. M. J. Yacaman, K. Heinemann, C. Y. Yang, and H. Poppe (NASA/Stanford Joint Institute for Surface and Microstructure Research, Moffett Field, Calif.). *Journal of Crystal Growth*, vol. 47, 1979, p. 187-195. 14 refs. Grant No. NsG-2249.

'Multiply-twinned' gold particles with hexagonal bright field TEM profile were determined to be icosahedra composed of 20 identical and twin-related tetrahedral building units that do not have an fcc structure. The crystal structure of these slightly deformed tetrahedra is rhombohedral. Experimental evidence supporting this particle model was obtained by selected-zone dark field and weak beam dark field electron microscopy. In conjunction with the results of part I, it has been concluded that multiply-twinned gold particles of pentagonal or hexagonal profile that are found during the early stages of the vapor deposition growth process on alkali halide surfaces do not have an fcc crystal structure, which is in obvious contrast to the structure of bulk gold.

(Author)

**A79-51696 \*** Crystallography of decahedral and icosahedral particles. II - High symmetry orientations. C. Y. Yang, M. J. Yacaman (NASA, Ames Research Center, Moffett Field, Calif.), and K. Heinemann (NASA, Ames Research Center; NASA/Stanford Joint Institute for Surface and Microstructure Research, Moffett Field, Calif.). *Journal of Crystal Growth*, vol. 47, Aug. 1979, p. 283-290. 17 refs.

Based on the exact crystal structure of decahedral and icosahedral particles, high energy electron diffraction patterns and image profiles have been derived for various high symmetry orientations of the particles with respect to the incident beam. These results form a basis for the identification of small metal particle structures with advanced methods of transmission electron microscopy.

(Author)

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**A79-51697 \*** Crystallography of decahedral and icosahedral particles. I - Geometry of twinning. C. Y. Yang (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Crystal Growth*, vol. 47, Aug. 1979, p. 274-282. 16 refs.

The crystal structure of the tetrahedral twins in multiply-twinned particles with decahedral and icosahedral point group symmetries has been examined and correlated with the face-centered cubic structure. Details on the crystal structure as well as the geometrical relationships among twins in each particle are presented. These crystallographic facts serve as a basis for the interpretation of small particle images obtained with advanced methods of transmission electron microscopy. (Author)

**A79-52070 \*** Electrical conductivity anomaly beneath Mare Serenitatis detected by Lunokhod 2 and Apollo 16 magnetometers. L. L. Vanian, T. A. Vnuchkova, I. V. Egorov (Akademiiia Nauk SSSR, Institut Okeanologii, Moscow, USSR), A. T. Basilevskii (Akademiiia Nauk SSSR, Institut Geokhimi i Analiticheskoi Khimii, Moscow, USSR); E. G. Eroshenko, E. B. Fainberg (Akademiiia Nauk SSSR, Institut Zemnogo Magnitizma, Ionosferы i Raspredeleniya Radiovoln, Moscow, USSR), P. Dyal (NASA, Ames Research Center, Moffett Field, Calif.), and W. D. Daily (Ewing Research Institute, Provo, Utah). *Moon and the Planets*, vol. 21, Oct. 1979, p. 185-192. 10 refs. Grant No. NSG-2082.

Magnetic fluctuations measured by the Lunokhod 2 magnetometer in the Bay Le Monnier are distinctly anisotropic when compared to simultaneous Apollo 16 magnetometer data measured 1100 km away in the Descartes highlands. This anisotropy can be explained by an anomalous electrical conductivity of the upper mantle beneath Mare Serenitatis. A model is presented of anomalously lower electrical conductivity beneath Serenitatis and the simultaneous magnetic data from the Lunokhod 2 site at the mare edge and the Apollo 16 site are compared to the numerically calculated model solutions. This comparison indicates that the anisotropic fluctuations can be modeled by a nonconducting layer in the lunar lithosphere which is 150 km thick beneath the highlands and 300 km thick beneath Mare Serenitatis. A decreased electrical conductivity in the upper mantle beneath the mare may be due to a lower temperature resulting from heat carried out the magma source regions to the surface during mare flooding. (Author)

**A79-52288 \*** The effect of external boundary conditions on condensation heat transfer in rotating heat pipes. T. C. Daniels (Swansea, University College, Swansea, Wales) and R. J. Williams (NASA, Ames Research Center, Moffett Field, Calif.). *International Journal of Heat and Mass Transfer*, vol. 22, Aug. 1979, p. 1237-1241. 6 refs.

Experimental evidence shows the importance of external boundary conditions on the overall performance of a rotating heat pipe condenser. Data are presented for the boundary conditions of constant heat flux and constant wall temperature for rotating heat pipes containing either pure vapor or a mixture of vapor and noncondensable gas as working fluid. (Author)

**A79-52332 \*** The vertical structure and thickness of Saturn's rings. J. N. Cuzzi (NASA, Ames Research Center, Moffett Field, Calif.), J. A. Burns (Cornell University, Ithaca, N.Y.), R. H. Durisen (Indiana University, Bloomington, Ind.), and P. M. Hamill (NASA, Langley Research Center, Hampton, Va.). *Nature*, vol. 281, Sept. 20, 1979, p. 202-204. 18 refs. Grant No. NSG-2227.

An explanation for the vertical structure and thickness of Saturn's rings compatible with observational data is presented. The model of the rings as being many particles thick is shown to be possible, with random particle motions preventing the complete flattening of the system and a gaussian distribution of particle density with vertical displacement. The model prediction of a maximum ring thickness of tens of meters, however, is in conflict with observations of ring thickness of at least 0.8 km at ring-plane passage. It is shown that perturbations to ring particle orbits caused by the sun and Saturn's large satellites may produce long- and short-period coherent vertical ring displacements and a nonlinear

displacement of the ring plane from the equatorial plane with radial distance, leading to an apparent edge-on thickness of a few hundred meters. A.L.W.

**A79-52550 \* //** Properties and effects of dust particles suspended in the Martian atmosphere. J. B. Pollack, D. S. Colburn (NASA, Ames Research Center, Space Science Div., Moffett Field, Calif.), F. M. Flasar (NASA, Goddard Space Flight Center, Greenbelt, Md.), R. Kahn (Harvard University, Cambridge, Mass.), C. E. Carlson, and D. Pidek (Martin Marietta Aerospace, Denver, Colo.). *Journal of Geophysical Research*, vol. 84, June 10, 1979, p. 2929-2945. 38 refs. Grant No. NSG-7398.

Direct measurements of the optical depth above the two Viking landers are presented for a period covering the summer, fall, and winter seasons in the Northern Hemisphere, a time period during which two global dust storms occurred. The data are used to define the properties of suspended dust particles in the Martian atmosphere and to assess their role in a number of meteorological and geological processes. Major conclusions are that (1) both the radiative effects of dust particles and the thermodynamical effects of large-scale atmospheric motions have a significant impact on the vertical temperature structure; (2) Pertinent feedback effects play an important part in the generation of some local dust storms, in the expansion of local dust storms to global proportions, and in the subsequent decay of global dust storms; (3) An important mechanism for the removal of dust particles from the atmosphere is the CO<sub>2</sub> condensation-sedimentation process; and (4) that the polar lamination are constructed from atmospheric dust and water ice is hypothesized. S.D.

**A79-52737 \*** The displacement field associated with line forces in a cracked orthotropic body. P. C. Gehlen (Battelle Columbus Laboratories, Columbus, Ohio) and J. P. Hirth (Ohio State University, Columbus, Ohio). *Computers and Structures*, vol. 9, Dec. 1978, p. 589-594. 12 refs. Contract No. NAS2-9183.

An explicit result is presented for the two-dimensional Green function for an orthotropic body containing a crack along an orthotropic plane and with its tip in an orthotropic direction. A formal solution and a numerical program for its calculation are presented for a crack on a plane rotated about an orthotropic direction. The use of such Green functions to couple a finite element mesh to a surrounding elastic continuum, thereby shortening finite element calculations for composite bodies with macroscopic orthotropic symmetry, is discussed. (Author)

**A79-52811 \*** Abrasion of windblown particles on Mars - Erosion of quartz and basaltic sand under simulated Martian conditions. D. Krinsley, R. Greeley (Arizona State University, Tempe, Ariz.), and J. B. Pollack (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). *Icarus*, vol. 39, Sept. 1979, p. 364-384. 34 refs. Grants No. NCA2-ORO35-801; No. NCA2-ORO35-901.

The results of a series of laboratory experiments initiated to simulate Martian eolian erosion are presented. Experiments were conducted under Martian atmospheric pressure and compared to natural eolian sand produced on earth. It is reported that the less dense atmosphere on Mars resulted in more energetic eolian erosion manifested by a slightly higher rate of grain rounding and surface textures that included semicircular depressions termed 'popouts'. It is suggested that physical and chemical weathering may proceed more rapidly on Mars than on earth, given a sufficient supply of water vapor. In addition, clay mineral formations should be facilitated by the presence of large amounts of disrupted material. Finally, it is noted that the disrupted material could increase the ability of the soil to act as a reservoir for water thereby provisionally explaining the large amount of bound water on the surface soil material over much of Mars. M.E.P.

**A79-52815 \*** Cosmic ray ionization of the Jovian atmosphere. L. A. Capone (San Jose State University, San Jose, Calif.), J. Dubach (Instituut voor Kernfysisch Onderzoek, Amsterdam,

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Netherlands), R. C. Whitten (NASA, Ames Research Center, Space Science Div., Moffett Field, Calif.), and S. S. Prasad (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Icarus*, vol. 39, Sept. 1979, p. 433-449. 48 refs.

An approximate form of the Boltzmann equation has been used to obtain local ionization rates due to the absorption of galactic cosmic rays in the Jovian atmosphere. It is shown that the muon flux component of the cosmic-ray-induced cascade may be especially important in ionizing the atmosphere at levels where the total number density exceeds 10 to the 19th per cu cm (well below the ionospheric layers produced by solar EUV). A model containing both positive and negative ion reactions has been employed to compute electron and ion number densities. Peak electron number densities of the order of 1000 per cu cm may be expected even at relatively low magnetic latitudes. The dominant positive ions are NH<sub>4</sub><sup>+</sup> and C<sub>n</sub>H<sub>m</sub><sup>+</sup> cluster ions, with n at least 2; it is suggested that the absorption of galactic cosmic-ray energy at such relatively high pressures in the Jovian atmosphere (M about 10 to the 18th to 10 to the 20th per cu cm) and the subsequent chemical reactions may be instrumental in the local formation of complex hydrocarbons.

(Author)

**A79-53033 \*** Electromagnetic noise and radio wave propagation below 100 kHz in the Jovian atmosphere. I - The equatorial region. K. Rinnert, W. I. Axford (Max-Planck-Institut für Aeronomie, Katlenburg, West Germany), L. J. Lanzerotti (Bell Telephone Laboratories, Inc., Murray Hill, N.J.; Florida, University, Gainesville, Fla.), E. P. Krider (Arizona, University, Tucson, Ariz.), M. A. Uman (Florida, University, Gainesville, Fla.), G. Dehmel, and F. O. Gliem (Braunschweig, Technische Universität, Braunschweig, West Germany). *Journal of Geophysical Research*, vol. 84, Sept. 1, 1979, p. 5181-5188. 58 refs. Contract No. NAS2-9976.

The Galileo satellite program includes the delivery of an entry probe to the Jovian equatorial atmosphere in mid-1985. Optical and RF sensors for a lightning detection system are included as a part of the probe experimental payload. In this paper, calculations of the RF wave propagation and reflection characteristics of the equatorial Jovian atmosphere and ionosphere for frequencies less than 100 kHz are presented. It is shown that wave propagation is limited to line-of-sight and one-hop from the ionosphere. Results are also presented of a statistical treatment of the RF wave power densities for the case of a finite number of events and for the case of a uniformly distributed source. The results can be applied to specific RF experiment configurations concerned with establishing the statistical characteristics of Jovian lightning.

(Author)

**A79-53320 \*** The Pioneer Venus Missions. C. F. Hall (NASA, Ames Research Center, Moffett Field, Calif.). *International Astronautical Federation, International Astronautical Congress, 30th, Munich, West Germany, Sept. 17-22, 1979, Paper 79-147*. 14 p.

Two spacecraft with scientific instruments, a Multiprobe and an Orbiter, were sent to Venus by the USA in 1978 and successfully performed a series of measurements of the Venusian environment, in situ from the probes and remotely from the Orbiter. The paper discusses the scientific objectives of the missions, describes the spacecraft and trajectories, presents the performance of the spacecraft and instruments, and summarizes the scientific findings. The results indicate an excess of primordial argon at Venus; four distinct cloud layers were observed; four widely separated sites in both daylight and night time show almost no differences in atmospheric temperature and pressure below about 50 km altitude; winds up to 200 m/sec were observed at high altitudes; large plateaus were identified on the surface.

(Author)

**A79-53436 \*** SETI - High sensitivity searches at NASA with high speed tape recorders. J. Tarter (California, University, Berkeley, Calif.), J. Cuzzi, D. Black, M. Stull (NASA, Ames Research Center, Moffett Field, Calif.), T. Clark (NASA, Goddard Space Flight Center, Greenbelt, Md.), and F. Drake (National Astronomy and Ionosphere Center, Ithaca, N.Y.). *International Astronautical Federation, Inter-*

*national Astronautical Congress, 30th, Munich, West Germany, Sept. 17-22, 1979, Paper 79-A-43. 20 p. 9 refs. Grants No. NSG-2271; No. NCA2-OR050-702.*

The paper reports the two observing programs conducted to compare two techniques which have been proposed as methods for performing the requisite Fourier transformations in very large multichannel spectrum analysers (MCSA): the direct digital FFT and optical transform processor. The details of the observations at NRAO utilizing a direct digital FFT are given. A description of the NAIC, Arecibo observations utilizing an optical processor at the Environmental Research Institute of Michigan (ERIM) and a microdensitometer at Electromagnetics System Laboratories (ESL) is presented. For both observing programs, statistical analysis of the power spectra produced by the nonreal-time MCSAs (or post-processing) was accomplished.

V.T.

**A79-53656 \*** Hydromagnetic waves and turbulence in the solar wind. A. Barnes (NASA, Ames Research Center, Theoretical and Planetary Studies Branch, Moffett Field, Calif.). In: *Solar system plasma physics. Volume 1. (A79-53651 24-92)* Amsterdam, North-Holland Publishing Co., 1979, p. 249-319. 236 refs.

The paper presents a state-of-the-art review of interplanetary fluctuations, their origins, and their effects on the solar wind. Typical values of parameters to waves and turbulence in the solar wind are examined, along with a classification of large-amplitude waves. Cases where description by the MHD theory is qualitatively correct and where it can be misleading are noted. An attempt is made to state rigorously the essential points of hydromagnetic-wave theory and to identify areas in which theoretical research needs to be extended. The review covers the observed hydromagnetic fluctuations, their interpretation in terms of current theory, and the degree of closure between observation and theory. The spatial distribution and origins of waves in the solar wind are discussed.

V.P.

**A79-53663 \*** The interaction of the solar wind with Mars, Venus and Mercury. C. T. Russell (California, University, Los Angeles, Calif.). In: *Solar system plasma physics. Volume 2. (A79-53658 24-91)* Amsterdam, North-Holland Publishing Co., 1979, p. 207-252. 102 refs. Grant No. NGR-05-007-004; Contract No. NAS2-8408.

The history of investigation of the solar wind interaction with Mars, Venus, and Mercury is reviewed, and our knowledge on this interaction for each of the three planets is compared. The primary objective is to gain insight into the basic physical mechanisms operative in the earth's magnetosphere from a study of (the somewhat different) magnetospheres of the planets under consideration. Mercury and Venus have significant dipole moments which play an important part in solar wind interaction. The Martian magnetic moment appears to be too weak to influence solar wind interaction. As expected, the bow shock of Mercury and the earth are quite similar since the magnetic moment of each is sufficient to stand off the solar wind. The shocks of Venus and Mars are also similar, but the Venusian shock lies much closer to the planet than the Martian shock. Both Mercury and Venus show evidence of substorm-like field and particle behavior, but with clear differences in the time scale.

V.P.

**A79-54140 \*** Stellar occultation studies of the solar system. J. L. Elliot (Cornell University, Ithaca, N.Y.). In: *Annual review of astronomy and astrophysics. Volume 17. (A79-54126 24-90)* Palo Alto, Calif., Annual Reviews, Inc., 1979, p. 445-475. 130 refs. NSF Grant No. AST-76-14832; Grant No. NsG-2174.

The paper covers the principles, observational procedures, and results relating to occultations of stars by solar system bodies other than the moon. Physical processes involved in occultations are presented including (1) extinction by ring material, (2) differential refraction by a planetary atmosphere, (3) extinction by a planetary atmosphere, and (4) Fresnel diffraction by sharp edges. It is noted that from a sufficient number of immersion and emersion timings of a stellar occultation, the radius and ellipticity of the occulting body can be accurately determined. From an occultation by a planet

having an atmosphere, temperature, pressure, and number density profiles can be obtained along with information about the composition of the atmosphere and the extinction. V.T.

**A79-54462 \*** **Intensities and N2 collision-broadening coefficients measured for selected H2O absorption lines between 715 and 732 nm.** T. D. Wilkerson, G. Schwemmer, B. Gentry (NASA, Goddard Space Flight Center, Greenbelt, Maryland, University, College Park, Md.), and L. P. Giver (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.). *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 22, Oct. 1979, p. 315-331. 38 refs. Research supported by the University of Maryland; Grants No. NSG-2216; No. NCA2-OR420-701.

Intensities and N<sub>2</sub> collision-broadening coefficients are measured for 62 water vapor absorption lines between 715 and 732 nm potentially applicable to laser remote sensing of atmospheric water vapor. Absolute line strengths and widths were determined from spectra corrected for instrument resolution, air-path absorption and Lorentz and Doppler broadening for pure water vapor and water vapor-nitrogen mixtures in a multipass absorption cell with a base path length of 25 m (White cell). Line strengths are observed to range from 4 x 10 to the -25th to 4 x 10 to the -23rd kaysers/molecule per sq cm, and collision broadening coefficients are found to be approximately equal to 0.1 kaysers/atm. A.L.W.

**A79-54486 \*** **The mean Jovian temperature structure derived from spectral observations from 105 to 630 cm kaysers.** D. Goorvitch, E. F. Erickson, J. P. Simpson, and A. T. Tokunaga (NASA, Ames Research Center, Moffett Field, Calif.). *Icarus*, vol. 40, Oct. 1979, p. 75-86. 40 refs.

Far infrared observations of the thermal emission of Jupiter are used to determine the temperature at 1 bar. High-altitude observations of the whole-disk brightness temperature of Jupiter in the range of 100 to 347 kaysers were inverted to obtain a P-T profile between 1.5 and 0.06 atm, assuming as opacity sources the H<sub>2</sub> collisionally induced continuum and the rotation inversion bands of ammonia. The P-T profile derived from the spectrum reproduces the main features of the observed spectrum, with a slightly improved fit if the effects of ammonia haze opacity or NH<sub>3</sub> supersaturation in the saturated region are taken into account. The Jovian temperature is found to be 160 + or - 7 K at 1 bar, and 105 + or - 3 K at the inversion level at 0.15 bar. The 1-bar temperature is shown to be consistent with Jovian interior models which match the observed gravitational moment. A.L.W.

## PATENTS

**N79-11215#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AMBIENT CURE POLYIMIDE FOAMS Patent Application**  
Paul M. Sawko, Salvatore R. Ricciello, and Charles L. Haimermesh, inventors (to NASA) (Rockwell Intern., Thousand Oaks, Calif.). Filed 31 Oct. 1978 15 p  
(NASA-Case-ARC-11170-1; US-Patent-Appl-SN 956161) Avail: NTIS HC A02/MF A01 CSCL 07D

Flame and temperature resistant polyimide foams are prepared by the reaction of an aromatic dianhydride, (pyromellitic dianhydride) with an aromatic polysiocyanate, (polymethylene polyphenylisocyanate), in the presence of an inorganic acid and furfuryl alcohol. Usable acids include dilute sulfuric acid, dilute nitric acid, hydrochloric acid, polyphosphoric acid, and phosphoric acid, with the latter being preferred. The dianhydride and the isocyanate in about equimolar proportions constitute about 50% of the reaction mixture, the rest being made up with the acid and the alcohol in a ratio of about 1:10. An exothermic reaction between the acid and the alcohol provides the heat necessary for the other components to polymerize without recourse to external heat sources. The mixture can be sprayed on any surface to form polymeric foam in locations where the application of heat is not practical or possible, for instance, between walls or on mine tunnel surfaces. NASA

**N79-16915\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**LOW DENSITY BISMALEIMIDE-CARBON MICROBALLOON COMPOSITES Patent**

Demetrios A. Kourtidis and John A. Parker, inventors (to NASA) Issued 16 Jan. 1979 7 p Filed 16 Mar. 1977 Supersedes N77-19173 (15 - 10, p 1279)  
(NASA-Case-ARC-11040-1; US-Patent-4,135,019;  
US-Patent-Appl-SN-778195; US-Patent-Class-428-117;  
US-Patent-Class-156-331; US-Patent-Class-428-119;  
US-Patent-Class-428-73; US-Patent-Class-428-458;  
US-Patent-Class-428-375) Avail: US Patent and Trademark Office CSCL 11D

A process is described for the preparation of composite laminate structures of glass cloth preimpregnated with polybismaleimide resin and adhered to a polybismaleimide glass or aromatic polyamide paper honeycomb cell structure that is filled or partially filled with a syntactic foam consisting of a mixture of bismaleimide resin and carbon microballoons. The carbon microballoons are prepared by pyrolyzing phenolic microballoons and subsequently bonded using a 2% bismaleimide solution. The laminate structures are cured for two hours at 477 deg K and are adhered to the honeycomb bismaleimide adhesive using a pressure of 700 KN/sq m pressure at 450 deg K. The laminate composite is then post-cured for two hours at 527 deg K to produce a composite laminate having a density in the range from about 95 kilograms per cubic meter to 130 kilograms per cubic meter.

Official Gazette of the U.S. Patent and Trademark Office

**N79-18087#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**CRYOGENIC CONTAINER COMPOUND SUSPENSION STRAP Patent Application**

John W. Vorreiter, inventor (to NASA) Filed 22 Aug. 1978 13 p  
(NASA-Case-ARC-11157-1; US-Patent-Appl-SN-935827) Avail: NTIS HC A02/MF A01 CSCL 20L

A support strap for use in a cryogenic storage vessel for supporting the inner shell from the outer shell with a minimum heat leak is presented. The compound suspension strap is made from a unidirectional fiberglass epoxy composite material with an ultimate tensile strength and fatigue strength which are approximately doubled when the material is cooled to a cryogenic temperature. NASA

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**N79-22300\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PREPARATION OF HETEROCYCLIC BLOCK COPOLYMER OMEGA-DIAMIDOXIMES Patent**

Leonard O. Ross (Stanford Research Inst., Menlo Park, Calif.), Robert W. Rosser, and Mark Iannone, inventors (to NASA) (Stanford Research Inst., Menlo Park, Calif.) Issued 20 Mar. 1979 6 p Filed 17 Oct. 1977 Supersedes N78-10292 (16 - 01, p 0044)  
(NASA-Case-ARC-11060-1; US-Patent-4,145,524;  
US-Patent-Appl-SN-843090; US-Patent-Class-528-401;  
US-Patent-Class-260-307G; US-Patent-Class-528-422) Avail: US Patent and Trademark Office CSCL 11C

Diamidoxime monomers are intermolecularly and thermally condensed to form a heat and chemical resistant polymer containing 1,2,4-oxadiazole linkages, with identical bivalent organic radicals or any combination of bivalent organic radicals selected from the group consisting of -(CX<sub>2</sub>)<sub>P</sub>, where P ranges from 2 to 8 when X is fluorine and 2 to 18 when X is hydrogen, chlorine, nitro or aryl, arylene; and an oligometric or polymeric radical prepared by reacting a dicarboxylic acid halide with a fluorinated epoxide.

Official Gazette of the U.S. Patent and Trademark Office

**N79-22301#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PROCESS FOR THE PREPARATION OF NEW ELASTOMERIC POLYTRIAZINES Patent Application**

Robert W. Rosser and Roger A. Korus, inventors (to NASA) (San Jose State Univ., Calif.) Filed 9 Apr. 1979 15 p  
(NASA-Case-ARC-11248-1; US-Patent-Appl-SN-028300) Avail: NTIS HC A02/MF A01 CSCL 07D

New crosslinked elastomeric polytriazines were prepared by a 4 step procedure which consists of: (1) forming a poly(imidoylamidine) by the reaction under reflux conditions of anhydrous ammonia with certain perfluorinated alkyl or alkylene dinitriles; (2) forming a linear polytriazine by cyclizing the imidoylamidine linkages by reaction with certain perfluorinated alkyl or alkyleneether acid anhydrides or halides; (3) extending the linear polytriazine chain by further refluxing in anhydrous ammonia; and (4) heating to cyclize the new imidoylamidine linkages and thereby crosslink the polymer.

NASA

**N79-22302\***# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**THE 1,2,4-OXADIAZOLE ELASTOMERS Patent Application**  
Robert W. Rosser, Ibrahim M. Shalhoub (San Jose State Univ. Foundation, Calif.), and Hanoi Kwong, inventors (to NASA) (San Jose State Univ. Foundation, Calif.) Filed 9 Apr. 1979 17 p (NASA-Case-ARC-11253-1; US-Patent-Appl-SN-028301) Avail: NTIS HC A02/MF A01 CSCL 07D

Crosslinked 1,2,4-oxadiazole elastomers were prepared by thermally condensing: (1) monomers having the formula  $H_2N(HON)C-R-Q$ , where Q is a triazine ring-forming group such as nitrile or amidine or a mixture of such groups with amidoxime; or (2) a mixture of said monomer with  $R[C(NOH)NH]_2$ , with R in these formulas standing for a bivalent organic radical having the formula: -(CX<sub>2</sub>) sub p-, or -CFY(OCF<sub>2</sub>CFY) sub m O(CX<sub>2</sub>) sub p O(CFYCF<sub>2</sub>) sub n CFY-, where X is fluorine or hydrogen, Y is fluorine or trifluoromethyl, p ranges from 1 to 18, and m + n ranges from 2 to 7. In the monomer charge, the overall proportions of amidoxime groups to triazine ring-forming groups varies depending on the extent of crosslinking desired in the final polymer.

NASA

**N79-23432\***# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**HIGH ACCELERATION CABLE DEPLOYMENT SYSTEM Patent Application**

Thomas N. Canning, Christopher E. Barns, James P. Murphy, Bobby Gin, and Robert W. King, inventors (to NASA) Filed 23 Apr. 1979 13 p (NASA-Case-ARC-11256-1; US-Patent-Appl-SN-032305) Avail: NTIS HC A02/MF A01 CSCL 20K

A high acceleration umbilical cable deployment system was devised for enabling electrical communication between a ballistic projectile forebody and an afterbody. A cable coiled on a spool is housed within a ballistic casing having a drag funnel at the rear end. The cable is sandwiched between a foam plug and the drag funnel before it leaves the forebody and is secured in a strain relief at the apex of a funnel in the afterbody. On deployment, when the bodies are separated, energies that would tend to rupture the cable are expended by the funnels, plug and strain relief.

NASA

**N79-24062\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**FIBROUS REFRACtORY COMPOSITE INSULATION Patent**

Daniel B. Leiser (Stanford Univ., Calif.), Howard E. Goldstein (Stanford Univ., Calif.), and Marnell Smith, inventors (to NASA) (Stanford Univ., Calif.) Issued 10 Apr. 1979 5 p Filed 8 Sep 1978 Supersedes N78-32189 (16 - 23, p 3052) Sponsored by NASA (NASA-Case-ARC-11169-1; US-Patent-4,148,962; US-Patent-Appl-SN-940688; US-Patent-Class-428-366) Avail: US Patent and Trademark Office CSCL 11D

A refractory composite insulating material was prepared from silica fibers and aluminosilicate fibers in a weight ratio ranging from 1:19 to 19:1, and about 0.5 to 30% boron oxide, based on the total fiber weight. The aluminosilicate fiber and boron oxide requirements may be satisfied by using aluminoborosilicate fibers and, in such instances, additional free boron oxide may be incorporated in the mix up to the 30% limit. Small quantities of refractory opacifiers, such as silicon carbide, may be also added. The composites just described are characterized by the absence of a nonfibrous matrix.

Official Gazette of the U.S. Patent and Trademark Office

**N79-24163\***# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**NEW PERFLUOROALKYL POLYTRIAZINES CONTAINING PENDENT IODODIFLUOROMETHYL GROUPS Patent Application**

Robert W. Rosser and Theodore Psarras, inventors (to NASA) (PCR, Inc., Gainesville, Fla.) Filed 8 May 1979 11 p (NASA-Case-ARC-11241-1; US-Patent-Appl-SN-037066) Avail: NTIS HC A02/MF A01 CSCL 07C

The synthesis of a sealer for aircraft structures is described. Perfluoroalkyl polytriazines containing pendent iodo difluoro methyl groups are prepared by the reaction of perfluoro alkyl dinitriles with ammonia to form poly(imidoylamides), followed by the cyclization of the imidoylamidine groups with, e.g. various mixtures of a perfluoroacyl fluoride with an omega-iodo perfluoro acyl fluoride. The polytriazines obtained are cured by heat which causes crosslinking at the iodo difluoro methyl groups by elimination of iodine and formation of carbon to carbon bonds.

NASA

**N79-26100\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**FIRE PROTECTION COVERING FOR SMALL DIAMETER MISSILES Patent**

Salvatore R. Ricciello and Paul M. Sawko, inventors (to NASA) Issued 29 May 1979 7 p Filed 25 Nov. 1977 Supersedes N78-13110 (16 - 03 p 0437)

(NASA-Case-ARC-11104-1; US-Patent-4,156,752; US-Patent-Appl-SN-854920; US-Patent-Class-428-220; US-Patent-Class-26C-37EP; US-Patent-Class-260-830S; US-Patent-Class-264-102; US-Patent-Class-264-145; US-Patent-Class-264-151; US-Patent-Class-264-175; US-Patent-Class-264-236; US-Patent-Class-244-121; US-Patent-Class-428-413; US-Patent-Class-428-414; US-Patent-Class-428-418; US-Patent-Class-428-421; US-Patent-Class-428-920) Avail: US Patent and Trademark Office CSCL 16D

Flexible intumescent protection sheeting of unusually uniform thickness were prepared from epoxy-polysulfide compositions, containing microfibers and the ammonium salt of 1,4-nitroaniline-2-sulfonic acid, as disclosed in U.S. Pat. No. 3,663,464, except that an ammonium salt particle size in the order of 5 to 8 microns and a fiber size of about 1/128th inch in length and 3 to 5 microns in diameter were found critical to obtain the required density of 1.46 to 1.50 g/cc. The insulation sheeting was prepared by a continuous process involving vacuum mixing, calendering, and curing under very strict conditions which depend to some extent upon the thickness of the sheet produced.

Official Gazette of the U.S. Patent and Trademark Office

**N79-30375\***# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**AN IMPROVED SYNTHESIS OF 2,4,8,10-TEXTROXASPIRO(5,5)DECANE Patent Application**

Algirdas C. Poshkus, inventor (to NASA) (NAS-NRC) Filed 3 Jul. 1979 12 p Sponsored by NASA (NASA-Case-ARC-11243-1; US-Patent-Appl-SN-054502) Avail: NTIS HC A02/MF A01 CSCL 07D

Pentaery thritol is converted to its diformal, 2,4,8,10-tetraox aspiro (5,5)undecane, by heating it to a temperature within the range of about 110 to 150 C for a period of up to 10 minutes, in the presence of a slight excess of paraformaldehyde and of a catalytic quantity of an acid catalyst such as sulfuric acid. The reaction is carried out in two steps, by forming first the monoformal, then the diformal. The total reaction time is about 10 minutes and yield of diformal are greater than 90%.

**N79-30376\***# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**IMPROVED SYNTHESIS OF POLYFORMALS Patent Application**

Algirdas C. Poshkus, inventor (to NASA) (NAS-NRC) Filed 3 Jul. 1979 9 p Sponsored by NASA (NASA-Case-ARC-11244-1; US-Patent-Appl-SN-054501) Avail: NTIS HC A02/MF A01 CSCL 07C

Formals of  $\text{CH}_2\text{OH}(\text{CHOH})_n\text{CH}_2$  polyols ( $n = 2$  to 4) are prepared in less than 15 minutes by heating to about 125°C. a mixture of e.g. sorbitol and paraformaldehyde in slight excess (5 to 10%), in the presence of e.g. sulfuric acid in catalytic quantities. Elution with methanol and filtration yield the pure solid cyclic triformal. The process can be carried in stages, using most stoichiometric quantities of paraformaldehyde, but without any change in overall heating time. NASA

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# LIFE SCIENCES

## FORMAL REPORTS

**N79 11651\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

### **US EXPERIMENTS FLOWN ON THE SOVIET SATELLITE COSMOS 782 Final Reports**

Susan N. Rosenzweig (Northrup Serv. Inc., Anaheim, Calif.) and Kenneth A. Souza Sep. 1978 416 p. refs. (NASA-TM-78525 A 76121) Avail. NTIS HC A18/MF A01 CSCL 06B

Experiment hardware preflight activities or orbit activities and postflight activities relevant to the 11 U.S. experiments on board the Soviet spacecraft are described. For individual titles see N79-11652 through N79-11670

**N79 11652\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

### **US EXPERIMENTS FLOWN ON COSMOS 782 Final Report**

Wayne H. Howard and Kenneth A. Souza *In its US Expt. Flown on the Soviet Satellite COSMOS 782* Sep. 1978 p 1-32 (For primary document see N79-11651 02-51)

Avail. NTIS HC A18/MF A01 CSCL 06B

The Cosmos 782 mission is summarized. Seven countries participated with experiments in 15 categories. The experiments in general concentrated on comparing the effects of weightlessness versus artificial gravity on genetics, growth, development and aging. The 11 U.S. experiments used rats, fruit flies, carrot tissue slices, embryos, fish eggs, and radiation dosimeters. Lists of participating countries, experiments, and mission operations are presented. The U.S. experiment hardware, preflight activities, and postflight activities are briefly described. SBS

**N79 11653\*** San Francisco Univ., Calif., Dept. of Physics  
**HZE PARTICLE DOSIMETRY Final Report**

D. D. Peterson, E. V. Benton and M. Tran *In its NASA Ames Res. Center US Expt. Flown on the Soviet Satellite COSMOS 782* Sep. 1978 p 160-178 refs (For primary document see N79-11651 02-51)

(Contract NAS2-7069)

Avail. NTIS HC A18/MF A01 CSCL 03B

**N79 11660\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

### **ABSENCE OF GASTRIC ULCERATION IN RATS AFTER FLIGHT ON THE COSMOS 782 Final Report**

P. A. Brown and J. Vernikos-Danellis *In its US Expt. Flown on the Soviet Satellite COSMOS 782* Sep. 1978 p 200-206 refs (For primary document see N79-11651 02-51)

Avail. NTIS HC A18/MF A01 CSCL 06C

Evidence of gastric ulceration or severe erosion of the gastric mucosa was sought in rats following 19.5 days of spaceflight on the Cosmos 782 Biological Satellite. The stomachs from the flight animals were compared macroscopically and histologically with stomachs removed from animals in the synchronous and vivarium control groups. None of the animals in the flight or the control groups ulcerated, and there were no obvious histologic differences in gastric erosion among the groups. The reasons for this failure to ulcerate are discussed. Author

**N79-11661\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

### **EFFECT OF SPACE FLIGHT ON CELL-MEDIATED IMMUNITY Final Report**

Adrian D. Mandel and Edward Balish (Wisconsin Univ., Madison) *In its US Expt. Flown on the Soviet Satellite COSMOS 782* Sep. 1978 p 207-226 refs (For primary document see N79-11651 02-51)

Avail. NTIS HC A18/MF A01 CSCL 06C

The cell mediated immune response to Listeria monocytogenes was studied in rats subjected to 19.5 days of flight in a Soviet spacecraft. Groups of rats were immunized with 1,000,000 formalin killed Listeria suspended in Freunds Complete adjuvant five days prior to flight. Immunized rats subjected to the same environmental parameters as the flight rats, excepting flight, and immunized and non-immunized rats held in a normal animal colony served as controls. Following recovery, lymphocyte cultures were prepared from spleens of all rats, and cultured *in vitro* in the presence of Listeria antigens, phytohemagglutinin, Concanavalin A, and purified protein derivative (PPD), and measured for their uptake of  $^{3}H$  thymidine. The lymphocytes of all rats gave a blastogenic response to phytohemagglutinin and Concanavalin A. Although individual rats varied considerably, all flight and immunized control rats gave a blastogenic response to the Listeria antigens and PPD. With several mitogens the lymphocytes of flight rats showed a significantly increased response over the controls. The data do not support a hypothesis of a determined effect of space flight on cell mediated immunity and suggest an opposite effect.

Author

**N79 11662\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

### **EXPERIMENT K 002: RESULTS OF HISTOLOGICAL EXAMINATION OF INGUINAL LYMPH NODES, SUPPLEMENTARY REPORT Final Report**

Lisbeth M. Kraft *In its US Expt. Flown on the Soviet Satellite COSMOS 782* Sep. 1978 p 227-231 (For primary document see N79-11651 02-51)

Avail. NTIS HC A18/MF A01 CSCL 06C

Lymph nodes of the vivarium control group showed only normal variations of structure. Both nodular and diffuse arrangement of the parenchyma are found, which is further reflected in the fibrous framework as seen in picrofuchsin preparations. Active germinal centers with pyronin positive cells are found in some of the nodes of three rats of this group. Mitoses are occasionally observed. Necrotic cells and debris within the centers are normal in amount. The sinuses contain the cells usually seen: lymphocytes, histiocytes, plasma cells, and some erythrocytes. Author

**N79 11663\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

### **ALTERATIONS IN ERYTHROCYTE SURVIVAL PARAMETERS IN RATS AFTER 19.5 DAYS ABOARD COSMOS 782 Final Report**

Henry A. Leon, Stephen A. Landaw (Veterans Admin. Hosp., Syracuse, N.Y.) and Jennifer Cummins *In its US Expt. Flown*

on the Soviet Satellite COSMOS 782 Sep 1978 p 232-252 refs (For primary document see N79-11651 02-51)  
Avail NTIS HC A18/MF A01 CSCL 06C

Rats were subjected to 19.5 of weightless space flight aboard the Soviet Biosatellite Cosmos 782. The survival parameters of a cohort of erythrocytes labeled 15.5 days pre-flight based on the output of Co 14 were evaluated upon return from orbit. These were compared to vivarium control rats injected at the same time. Statistical evaluation indicates that all survival parameters were altered by the space flight. The mean potential life span which was 62.4 days in the control rats was decreased to 59.0 days in the flight rats, and random hemolysis was increased three fold in the flight rats. The measured size of the cohort was decreased lending further support to the idea that hemolysis was accelerated during some portion of the flight. A number of factors were discussed which might be contributory to these changes. These factors include forces associated with launch and re-entry, atmospheric and environmental parameters, dietary factors, radiation and weightlessness. Author

**N79-11664\***# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

**EFFECTS OF SPACE FLIGHT ON PLASMA AND GLANDULAR CONCENTRATIONS OF PITUITARY HORMONES Final Report**

R E Grindeland, L C Keil, S Ellis, A F Parlow (Calif Univ Los Angeles) J W Kendall Jr (Veteran's Admin Hosp Portland Oreg) Donna Gaudette (Veteran's Admin Hosp Portland Oreg) and I I Geschwind (Calif Univ Davis). In its US Expt Flown on the Soviet Satellite COSMOS 782 Sep 1978 p 253-275 refs (For primary document see N79-11651 02-51)

Avail NTIS HC A18/MF A01 CSCL 06C

Pituitary function was investigated in rats subjected to 19.5 days orbited space flight. Male SPF Wistar rats were divided into vivarium control (VC), synchronous control (SC) and flight (F) groups. SC rats were subjected to the same caging RHOO2, RHOO2, and temperature as F rats. Rats from each treatment group were sacrificed either immediately after recovering from flight (R-0) or 25 days after recovery. Space flight caused a marginal inhibition of growth. Pituitary concentrations of hormones were similar for all groups as were the hematocrits. At R-25 F rats had increased plasma prolactin concentrations, decreased pituitary GH and increased pituitary vasopressin. Pituitary and plasma concentrations of other hormones remained unchanged from control values. Hematocrits of flight rats were higher than VC and SC values at R-25 and higher than for F rats at R-0. Anterior pituitary and testicular weights were unaffected by space flight whereas adrenal weights (2 rats from each group) were 30% heavier than controls at R-0 and 15% heavier at R-25. Flight rats also had enlarged posterior lobes. Author

**N79-11668\***# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

**QUANTITATIVE ANALYSIS OF SELECTED BONE PARAMETERS Final Report**

Emily Morey Holton and David J Baylink (Veterans Admin Hospital Seattle). In its US Expt Flown on the Soviet Satellite COSMOS 782 Sep 1978 p 321-351 refs (For primary document see N79-11651 02-51)

Avail NTIS HC A18/MF A01 CSCL 06C

The effect of space flight on bone formation and mineralization, bone resorption, bone length, bone density and pore size distribution and bone mechanical properties in rats was investigated and compared to vivarium and synchronous controls. The most striking effects were found on bone formation. All parameters were investigated in the flight animals immediately after flight were significantly decreased from both the vivarium and synchronous control groups. An arrest line was found at both the endosteum and the periosteum of the flight animals suggesting that a complete cessation of bone growth occurred during space flight. By 25 days postflight the flight animals showed a significant increase in bone formation when compared to the vivarium controls suggesting that a rebound in bone formation occurred following flight. Author

**N79-11669\***# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

**COSMIC RAY EFFECTS ON THE EYES OF RATS FLOWN ON COSMOS 782 Final Report**

Delbert E Philpott, Robert Corbett, Charles Turnbull, Gladys Harrison, David Leaffer, Sam Black, Walter Sapp, Gloria Klein, and Loya F Savik. In its US Expt Flown on the Soviet Satellite COSMOS 782 Sep 1978 p 352-381 refs (For primary document see N79-11651 02-51)

Avail NTIS HC A18/MF A01 CSCL 06R

The eyes from six rats were fixed at the recovery site in Russia after circling the earth for 19.5 days in a 62.8 deg orbit. Twelve more flight eyes were fixed 25 days later. These two preparations and eyes exposed to 1000 rads of neon and argon were compared to obtain data on possible radiation effects on the retina. The outer nuclear layer was examined for radiation changes because these nuclei control the synthesis of the outer segments. Necrotic nuclei were found in the outer nuclear layer and channels were located in the outer segment area. Macrophages were seen between the pigment layer and outer segments. Comparison of the zero day and 25 day postflight eyes suggested some possible recovery. Flight flashes seen by space travelers and damage from cosmic rays appeared to arise from two different sites of interaction. The flashes are created by cosmic ray traversal of the outer segments while pathology when it occurs is quite possibly from interaction with some part of the nucleus. Author

**N79-11670\***# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

**EFFECTS OF WEIGHTLESSNESS ON THE EMBRYONIC DEVELOPMENT AND AGING OF DROSOPHILA Final Report**

J Miguel, D E Philpott, P R Lundgren, R Binnard and C E Turnbull. In its US Expt Flown on the Soviet Satellite COSMOS 782 Sep 1978 p 382-409 refs (For primary document see N79-11651 02-51)

Avail NTIS HC A18/MF A01 CSCL 06C

The biological effects of weightlessness were investigated on Drosophila melanogaster of the Domodedov 32 strain which developed and spent the first days of adult life in space. Following a 19.5 day exposure to zero g the flies were studied by morphological, chemical and behavioral techniques. The development of Drosophila was insensitive to weightlessness and the aging process was not influenced except for a slight reduction in the amount of lipofuscin present in the midgut and Malpighian tubules. Author

**N79-11671\***# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

**US EXPERIMENTS FLOWN ON THE SOVIET SATELLITE COSMOS 936 Final Reports**

Susan N Rosenzweig (Northrop Services Inc Anaheim Calif) and Kenneth A Souza Sep 1978 295 p refs (NASA TM 78526 A 7616) Avail NTIS HC A13 MF A01 CSCL 06B

Results of spaceborne experiments onboard the Cosmos 936 satellite are reported. Alterations in normal bone chemistry, muscle structure and general physiology resulting from spaceflight are covered along with measurements of cosmic radiation and its potential hazard to man during prolonged spaceflights. Postflight activities involving the seven U.S. experiments are emphasized. For individual titles see N79-11672 through N79-11679.

**N79-11672\***# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

**THE COSMOS 936 MISSION Final Report**

Kenneth A Souza. In its US Expt Flown on the Soviet Satellite COSMOS 936 Sep 1978 p 1-31 refs (For primary document see N79-11671 02-51)

Avail NTIS HC A13 MF A01 CSCL 06C

Cosmos 936 an unmanned spacecraft carrying biology and physics experiments from 9 countries including both the Soviet

Union and the U.S. is described. An overview of the mission focusing on preflight, on-orbit, and postflight activities pertinent to the seven U.S. experiments aboard Cosmos 936 is presented.

JMS

**N79-11673\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**EFFECTS OF WEIGHTLESSNESS ON THE GENETICS AND AGING PROCESS OF DROSOPHILA MELANOGASTER Final Report**

Jaime Miquel and Delbert E. Philpott. *In its US Expt Flown on the Soviet Satellite COSMOS 936 Sep 1978 p 32-59 refs* (For primary document see N79-11671 02-51)

Avail NTIS HC A13/MF A01 CSCL 06C

The biological effects of space flight were investigated on fruit flies (male *Drosophila melanogaster* Oregon R) in an experiment planned jointly with the USSR. The effects of near weightlessness on the developmental and aging processes were studied. Larval cultures and mature flies (imagoes) were exposed to the space environment onboard the Cosmos 936 biosatellite. It is shown that the effect of hypogravity on the development processes of *Drosophila* is negligible. In effect detailed investigation by scanning and transmission electron microscopy of flies which had developed in space shows that the external morphology and the internal fine structure of these insects are perfectly normal. This suggests that, at least in *Drosophila*, the mechanism of cell division and differentiation associated with growth and morphogenesis are not appreciably influenced by the lack of gravity. The fly populations which were exposed to near-weightlessness during the young or middle age phases of their adult life span show reduced vitality and a detrimental effect on longevity.

JMS

**N79-11674\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**EFFECT OF WEIGHTLESSNESS AND CENTRIFUGATION (1G) ON ERYTHROCYTE SURVIVAL IN RATS-SUBJECTED TO PROLONGED SPACE FLIGHT Final Report**

Henry A. Leon, Stephen A. Landaw (Veterans Administration Hospital, Syracuse, N.Y.) and Luba V. Serova (Inst for Biomedical Problems, Moscow). *In its US Expt Flown on the Soviet Satellite COSMOS 936 Sep 1978 p 60-76 refs* (For primary document see N79-11671 02-51)

Avail NTIS HC A13/MF A01 CSCL 06S

Rats were flown aboard the biosatellite Cosmos 936 for 18.5 days. Five rats were subjected to near weightless space flight and five rats were subjected to a one g force via an onboard centrifuge. These rats and 3 control groups were injected with <sup>2</sup>C-14 glycine 19 days preflight. The flight rats were recovered from orbit after 18.5 days of space flight. Erythrocyte hemolysis and life span were evaluated in the five groups of rats by quantitation of radioactive carbon monoxide exhaled in the breath which arises from the breakdown of the previously labeled hemoglobin. The results are supportive of previous findings wherein hemolysis was found to increase as a result of weightless space flight. A comparison with the centrifuged animals indicates that artificial gravity attenuates the effect of weightlessness on hemolysis and appears to normalize the hemolytic rate in the early postflight period.

JMS

**N79-11675\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**COSMOS 936, EXPERIMENT K204 THE EFFECTS OF SPACE FLIGHT ON SOME LIVER ENZYMES CONCERNED WITH CARBOHYDRATE AND LIPID METABOLISM IN THE RAT Final Report**

S. Abraham (Children's Hospital Medical Center of Northern Calif.), H. P. Klein, C. Y. Lin (Children's Hospital Medical Center of Northern Calif.) and C. Volkmann. *In its US Expt Flown on the Soviet Satellite COSMOS 936 Sep 1978 p 78-134 refs* (For primary document see N79-11671 02-51)

Avail NTIS HC A13/MF A01 CSCL 06C

The activities of about 30 enzymes concerned with carbohydrate and lipid metabolism and the levels of glycogen and of the individual fatty acids in hepatic lipids in rat livers exposed to space flight conditions were examined. Statistically significant decreases in the activity levels of glycogen phosphorylase, alpha-glycerol phosphate acyl transferase, diglyceride acyl transferase, aconitase, and 6-phosphoglucomate dehydrogenase were noted in the weightless group. All enzyme activities returned to normal 25 days postflight. When the liver glycogen and the total fatty acids of the flight animals were determined, significant differences that could be attributed to reduced group at recovery contained more than twice the amount of glycogen than did the centrifuged controls and a remarkable shift in the ratio of palmitate to palmitoleate was noted.

JMS

**N79-11676\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**QUANTITATIVE ANALYSIS OF SELECTED BONE PARAMETERS Final Report**

Emily Morey Holton, Russell T. Turner (Veterans Administration Hospital, Tacoma, Wash.) and David J. Baylink (Veterans Administration Hospital, Tacoma, Wash.). *In its US Expt Flown on the Soviet Satellite COSMOS 936 Sep 1978 p 135-183 refs* (For primary document see N79-11671 02-51)

Avail NTIS HC A13/MF A01 CSCL 06S

The effect of space flight on bone formation, bone resorption, bone length, bone density and pore size distribution, bone mechanical properties and bone cell number in both flight and 1 G flight centrifuged rats was investigated and compared to ground control groups. The data obtained suggest that no gross change in endosteal bone resorption occurs during flight or postflight; that mean periosteal bone formation rate decreases about 45% and is not corrected by centrifugation; that the decrease in formation rate may be due in part to a cessation of bone formation which occurs sometime after the eleventh day of flight and continues until the second postflight day; that although centrifugation did not correct the defect in periosteal bone formation rate during flight, it appears to hasten the recovery following flight; that femur stiffness decreases about 30%; and that centrifugation did correct the defect in bone mechanical properties. All perturbations produced by space flight returned to or exceeded normal values by 25 days after flight.

Author

**N79-11677\*** San Francisco Univ., Calif. Physics Research Group

**SPACE RADIATION DOSIMETRY ONBOARD COSMOS 936: US PORTION OF EXPERIMENT K 206 Final Report**

E. V. Benton, R. Cassou, A. Frank, R. P. Henke and D. D. Peterson. *In NASA Ames Res. Center US Expt Flown on the Soviet Satellite COSMOS 936 Sep 1978 p 184-245 refs* (For primary document see N79-11671 02-51)

(Contract NAS2-9504)

Avail NTIS HC A13/MF A01 CSCL 06R

The space radiation environment was investigated in a joint U.S.-U.S.S.R. experiment onboard the Cosmos 936 biosatellite. Results derived from measurements made in a variety of passive radiation detectors including plastic nuclear track detectors, fission foil detectors, thermoluminescence dosimeters, and nuclear emulsions are reported. The mean observed HZE particle flux as measured in cellulose nitrate plastic detectors was 1.75 sq cm/day ( $\pm 20\%$ ). The fluences of thermal neutrons, resonance neutrons, and high energy neutrons were, respectively, 364 000 sq cm, 950 000 sq cm, and 2 100 000 sq cm. The total dose, as measured in TLD chips located at two sites in the U.S. 25% part of the K-206 container was 424 mrad ( $\pm 9\%$ ) and 523 mrad ( $\pm 11\%$ ). The mean tissue equivalent proton ender density, as measured in nuclear emulsions located in the U.S. 25% part, was 272 000 cu cm/tissue. The physical parameters of the radiation environment reported help specify important dosimetric information required to assess the potential radiation hazards to life systems in space.

JMS

**N79-11678\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif  
**COSMIC RAY EFFECTS ON THE EYES OF STATIONARY AND CENTRIFUGED RATS FLOWN ON COSMOS 936. EXPERIMENT K-207 Final Report**

Delbert E Philpott, Robert Corbett, Charles Turnbull, Sam Black, Dayhoff, Jackie McGourty, Robert Lee and Gladys Harrison /in its US Expt Flown on the Soviet Satellite COSMOS 936 Sep 1978 p 246-273 refs (For primary document see N79-11671 02-51)

Avail NTIS HC A13/MF A01 CSCL 05R

Ten rats, 5 centrifuged during flight to simulate gravity and 5 in flight stationary experiencing hyogravity, orbited the earth in a 62.8 deg orbit for 18.5 days in the Russian satellite Cosmos 936. The animals were sacrificed 25 days post-recovery and the eyes were enucleated and fixed immediately. No differences were noted comparing flight stationary to flight centrifuged. Affected cells in the outer nuclear layer where synthesis of the outer segment takes place, showed swelling, clearing of cytoplasm, and disruption of the membranes. Channels were again found similar to those seen in K-007. Preliminary results using the digitizer to quantitate the tissue response indicated an increase in cell size after radiation and decrease in the number of cells in the outer nuclear layer. Author

**N79-13686\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif  
**PHYSIOLOGICAL RESPONSES OF WOMEN TO SIMULATED WEIGHTLESSNESS: A REVIEW OF THE FIRST FEMALE BED-REST STUDY**

Harold Sandler and David L Winter 1978 92 p refs (NASA-SP-430) Avail NTIS HC A05/MF A01 CSCL 06S

Subjects were exposed to centrifugation, to lower body negative pressure (LBNP), and to exercise stress both before and after bed rest. Areas studied were centrifugation tolerance, fluid electrolyte changes and hematology, tolerance to LBNP, physical working capacity, biochemistries, blood fibrinolytic activity, female metabolic and hormonal responses, circadian alterations, and gynecology. Results were compared with the responses observed in similarly bed-rested male subjects. The bed-rested females showed deconditioning responses similar to those of the males, although with some differences. Results indicate that women are capable of coping with exposure to weightlessness and, moreover, that they may be more sensitive subjects for evaluating countermeasures to weightlessness and developing criteria for assessing applicants for shuttle voyages. G G

**N79-14060\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif  
**NASA AVIATION SAFETY REPORTING SYSTEM Quarterly Report, 1 Oct. - 31 Dec. 1977**

Aug 1978 61 p refs Prepared in cooperation with Battelle Columbus Labs, Mountain View, Calif (NASA-TM-78528, A-7626, QR-7) Avail NTIS HC A04/MF A01 CSCL 01C

A sample of reports relating to operations during winter weather is presented. Several reports involving problems of judgment and decisionmaking have been selected from the numerous reports representative of this area. Problems related to aeronautical charts are discussed in a number of reports. An analytic study of reports involving potential conflicts in the immediate vicinity of uncontrolled airports was performed; the results are discussed in this report. It was found that in three-fourths of 127 such conflicts, neither pilot, or only one of the pilots, was communicating position and intentions on the appropriate frequency. The importance of providing aural transfer of information, as a backup to the visual see and avoid mode of information transfer is discussed. It was also found that a large fraction of pilots involved in potential conflicts on final approach had executed straight-in approaches, rather than the recommended traffic pattern entries, prior to the conflicts. A selection of alert bulletins and responses to them by various segments of the aviation community is presented. G G

**N79-15014\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

**NASA AVIATION SAFETY REPORTING SYSTEM Quarterly Report, 1 Jan. - 31 Mar. 1978**  
Oct 1978 60 p refs Prepared in cooperation with Battelle Columbus Labs, Mountain View, Calif (NASA-TM-78540, A-7662, QR-8) Avail NTIS HC A04/MF A01 CSCL 01C

The study deals with 165 inadvertent operations on or into inappropriate portions of the aircraft areas at controlled airports. Pilot-initiated and controller-initiated incursions are described and discussed. It was found that a majority of the pilot-initiated occurrences involved operation without a clearance; controller-initiated occurrences usually involved failure to maintain assured separation. The factors associated with these occurrences are analyzed. It appears that a major problem in these occurrences is inadequate coordination among the various system participants. Reasons for this, and some possible solutions to various aspects of the problem, are discussed. A sample of reports from pilots and controllers is presented. These relate to undesired occurrences in air transport, general aviation, and air traffic control operations, to ATC coordination problems, and to a recurrent problem in ASRS reports, parachuting operations. A sample of alert bulletins and responses to them is presented. Author

**N79-15588\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif  
**THE 14TH ANNUAL CONFERENCE ON MANUAL CONTROL**

Nov 1978 692 p refs Conf held at Univ. of Southern Calif, Los Angeles, 25-27 Apr 1978 (NASA-CP-2060, A-7615) Avail NTIS HC A99/MF A01 CSCL 05H

Human operator dynamics during actual manual control or while monitoring the automatic control systems involved in air-to-air tracking, automobile driving, the operator of undersea vehicles, and remote handling are examined. Optimal control models and the use of mathematical theory in representing man behavior in complex man machine system tasks are discussed with emphasis on eye/head tracking and scanning, perception and attention allocation, decision making, and motion simulation and effects. For individual titles, see N79-15589 through N79-15634

**N79-15595\*** Illinois Univ., Urbana Dept of Mechanical and Industrial Engineering

**MODELING THE HUMAN AS A CONTROLLER IN A MULTITASK ENVIRONMENT**

T Govindaraj and William B Rouse /in NASA Ames Res Center The 14th Ann Conf on Manual Control Nov 1978 p 75-83 refs (For primary document see N79-15588 06-54) (Grant NsG-2119)

Avail NTIS HC A99/MF A01 CSCL 05H

Modeling the human as a controller of slowly responding systems with preview is considered. Along with control tasks, discrete noncontrol tasks occur at irregular intervals. In multitask situations such as these, it has been observed that humans tend to apply piecewise constant controls. It is believed that the magnitude of controls and the durations for which they remain constant are dependent directly on the system bandwidth, preview distance, complexity of the trajectory to be followed, and nature of the noncontrol tasks. A simple heuristic model of human control behavior in this situation is presented. The results of a simulation study whose purpose was determination of the sensitivity of the model to its parameters are discussed. Author

**N79-15599\*** Illinois Univ., Urbana Dept of Mechanical and Industrial Engineering

**PROSPECTS OF A MATHEMATICAL THEORY OF HUMAN BEHAVIOR IN COMPLEX MAN-MACHINE SYSTEMS TASKS**

Gunnar Johannsen and William B Rouse /in NASA Ames Res Center The 14th Ann Conf on Manual Control Nov

1978 p 137-159 refs (For primary document see N79-15588 06-54)  
(Grant NSG-2119)

Avail: NTIS HC A99/MF A01 CSCL 05H

A hierarchy of human activities is derived by analyzing automobile driving in general terms. A structural description leads to a block diagram and a time-sharing computer analogy. The range of applicability of existing mathematical models is considered with respect to the hierarchy of human activities in actual complex tasks. Other mathematical tools so far not often applied to man machine systems are also discussed. The mathematical descriptions at least briefly considered here include utility, estimation, control, queueing, and fuzzy set theory as well as artificial intelligence techniques. Some thoughts are given as to how these methods might be integrated and how further work might be pursued.

A.R.H.

**N79-15605\*** Illinois Univ., Urbana Dept. of Mechanical and Industrial Engineering

**ANALYSIS OF A VTOL HOVER TASK WITH PREDICTOR DISPLAYS USING AN OPTIMAL CONTROL MODEL OF THE HUMAN OPERATOR**

Gunnar Johannsen and T. Govindaraj /n NASA Ames Res. Center The 14th Ann. Conf. on Manual Control Nov. 1978 p 237-251 refs (For primary document see N79-15588 06-54)  
(Grant NSG-2119)

Avail: NTIS HC A99/MF A01 CSCL 05H

The influence of different types of predictor displays in a longitudinal VTOL hover task is analyzed in a theoretical study. It was assumed that pitch angle and position are presented to the pilot in separate displays namely the artificial horizon and position display. The predictive information is calculated by means of a Taylor series. From earlier experimental studies it is well known that predictor displays improve human and system performance and result in reducing human workload. In this study, an optimal control model is used to prove this effect theoretically. Several cases with differing amounts of predictive and rate information are compared.

G.Y.

**N79-15627\*** Massachusetts Inst. of Tech., Cambridge Man-Machine Systems Lab

**A MODEL FOR DYNAMIC ALLOCATION OF HUMAN ATTENTION AMONG MULTIPLE TASKS**

Thomas B. Sheridan and M. Kamil Tulga /n NASA Ames Res. Center The 14th Ann. Conf. on Manual Control Nov. 1978 p 569-592 refs (For primary document see N79-15588 06-54)  
(Grant NSG-2118)

Avail: NTIS HC A99/MF A01 CSCL 05H

The problem of multi-task attention allocation with special reference to aircraft piloting is discussed with the experimental paradigm used to characterize this situation and the experimental results obtained in the first phase of the research. A qualitative description of an approach to mathematical modeling, and some results obtained with it are also presented to indicate what aspects of the model are most promising. Two appendices are given which (1) discuss the model in relation to graph theory and optimization and (2) specify the optimization algorithm of the model.

Author

**N79-15628\*** San Jose State Univ., Calif.

**PERPETUAL FACTORS INVOLVED IN PERFORMANCE OF AIR TRAFFIC CONTROLLERS USING A MICROWAVE LANDING SYSTEM**

Gary Gershzohn /n NASA Ames Res. Center The 14th Ann. Conf. on Manual Control Nov. 1978 p 593-606 refs (For primary document see N79-15588 06-54)

(Grants NGL-05-046-002, NSG-2269)

Avail: NTIS HC A99/MF A01 CSCL 05H

The task involved the control of two simulated aircraft targets per trial, in a 37.0-km radius terminal area, by means of conventional radar vectoring and/or speed control. The goal was

to insure that the two targets crossed the Missed Approach Point (MAP) at the runway threshold exactly 60 sec apart. The effects on controller performance of the MLS configuration under wind and no-wind conditions were examined. The data for mean separation time between targets at the MAP and the range about that mean were analyzed by appropriate analyses of variance. Significant effects were found for mean separation times as a result of the configuration of the MLS and for interaction between the configuration and wind conditions. The analysis of variance for range indicated significantly poorer performance under the wind condition. These findings are believed to be a result of certain perceptual factors involved in radar air traffic control (ATC) using the MLS with separation of targets in time. Author

**N79-15632\*** Illinois Univ., Urbana Dept. of Mechanical and Industrial Engineering

**A MODEL OF HUMAN EVENT DETECTION IN MULTIPLE PROCESS MONITORING SITUATIONS**

Joel S. Greenstein and William B. Rouse /n NASA Ames Res. Center The 14th Ann. Conf. on Manual Control Nov. 1978 p 663-675 refs (For primary document see N79-15588 06-54)

(Grant NSG-2119)

Avail: NTIS HC A99/MF A01 CSCL 05H

It is proposed that human decision making in many multi-task situations might be modeled in terms of the manner in which the human detects events related to his tasks and the manner in which he allocates his attention among his tasks once he feels events have occurred. A model of human event detection performance in such a situation is presented. An assumption of the model is that, in attempting to detect events, the human generates the probability that events have occurred. Discriminant analysis is used to model the human's generation of these probabilities. An experimental study of human event detection performance in a multiple process monitoring situation is described and the application of the event detection model to this situation is addressed. The experimental study employed a situation in which subjects simultaneously monitored several dynamic processes for the occurrence of events and made yes/no decisions on the presence of events in each process. Input to the event detection model of the information displayed to the experimental subjects allows comparison of the model's performance with the performance of the subjects.

Author

**N79-15633\*** Illinois Univ., Urbana Dept. of Mechanical and Industrial Engineering

**PILOT DECISION MAKING IN A COMPUTER-AIDED FLIGHT MANAGEMENT SITUATION**

Yee-Yeen Chu and William B. Rouse /n NASA Ames Res. Center The 14th Ann. Conf. on Manual Control Nov. 1978 p 677-690 refs (For primary document see N79-15588 06-54)  
(Grant NSG-2119)

Avail: NTIS HC A99/MF A01 CSCL 05H

An experimental representation of a computer-aided multi-task flight management situation has been developed. A computer aiding program was implemented to serve as a back-up decision maker. An experiment was conducted with a balanced design of several subject runs for different workload levels. This was achieved using three levels of subsystem event arrival rates, three levels of control task involvement, and three levels of availability of computer aiding. Experimental results compared quite favorably with those from a computer simulation which employed a queuing model. It was shown that the aiding had enhanced system performance as well as subjective ratings, and that the adaptive aiding policy further reduced subsystem delay.

Author

**N79-15634\*** Utah Univ., Salt Lake City

**TIME ESTIMATION AS A SECONDARY TASK TO MEASURE WORKLOAD: SUMMARY OF RESEARCH**

Sandra G. Hart, Duncan McPherson (Calif. Univ., Berkeley), and Leslie L. Loomis (San Jose State Univ.) /n NASA Ames Res. Center The 14th Ann. Conf. on Manual Control Nov. 1978

p 693-712 refs (For primary document see N79-15588 06-54)  
(Grant NGR-45-003-108; NSG-2269)

Avail: NTIS HC A99/MF A01 CSCL 05H

Actively produced intervals of time were found to increase in length and variability, whereas retrospectively produced intervals decreased in length although they also increased in variability with the addition of a variety of flight-related tasks. If pilots counted aloud while making a production, however, the impact of concurrent activity was minimized, at least for the moderately demanding primary tasks that were selected. The effects of feedback on estimation accuracy and consistency were greatly enhanced if a counting or tapping production technique was used. This compares with the minimal effect that feedback had when no overt timekeeping technique was used. Actively made verbal estimates of sessions filled with different activities performed during the interval were increased. Retrospectively made verbal estimates, however, increased in length as the amount and complexity of activities performed during the interval were increased.

Author

N79-15884#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**VISION** c52  
Richard F. Haines / In its Human Neurol. Develop. Nov. 1978  
p 35-45 Original contains color illustrations (For primary document  
see N79-15887 06-99)

Avail: NTIS HC A04/MF A01 CSCL 06P

Visual input methods are considered for the therapeutic treatment of autistic and brain-damaged patients, and to provide a controlled stress environment for visual perception problems.

G.G.

N79-16769#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif. Extraterrestrial  
Biology Div.

**ORGANIC CHEMISTRY ON TITAN**

Sherwood Chang, Thomas Scattergood, Sheldon Aronowitz, and  
Jose Flores / In JPL The Saturn System Dec. 1978 p 161-184  
refs (For primary document see N79-16758 07-91)

Avail: NTIS HC A18/MF A01 CSCL 03B

Observations of nonequilibrium phenomena on the Saturn satellite Titan indicate the occurrence of organic chemical evolution. Greenhouse and thermal inversion models of Titan's atmosphere provide environmental constraints within which various pathways for organic chemical synthesis are assessed. Experimental results and theoretical modeling studies suggest that the organic chemistry of the satellite may be dominated by two atmospheric processes: energetic-particle bombardment and photochemistry. Reactions initiated in various levels of the atmosphere by cosmic ray, Saturn wind, and solar wind particle bombardment of a CH<sub>4</sub> - N<sub>2</sub> atmospheric mixture can account for the C<sub>2</sub>-hydrocarbons, the UV-visible-absorbing stratospheric haze, and the reddish color of the satellite. Photochemical reactions of CH<sub>4</sub> can also account for the presence of C<sub>2</sub>-hydrocarbons. In the lower Titan atmosphere, photochemical processes will be important if surface temperatures are sufficiently high for gaseous NH<sub>3</sub> to exist. Hot H-atom reactions initiated by photo-dissociation of NH<sub>3</sub> can couple the chemical reactions of NH<sub>3</sub> and CH<sub>4</sub> and produce organic matter.

G.G.

N79-19021#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**EFFECTS OF HYPODYNAMIC SIMULATIONS ON THE SKELETAL SYSTEM OF MONKEYS** c51

D. R. Young and J. W. Tremor / In NASA. Goddard Space Flight Center Ninth Conf. on Space Simulation 1977 p 123-140  
refs (For primary document see N79-19013 10-12)

Avail: NTIS HC A20/MF A01 CSCL 06C

A research and development program was undertaken to evaluate the skeletal losses of subhuman primates in hypodynamic environments. The goals of the program are: (1) to uncover the mechanisms by which weightlessness affects the skeletal system; (2) to determine the consequences and reversibility of bone mineral

losses; and (3) to acquire a body of data needed to formulate an appropriate countermeasure program for the prevention of skeletal deconditioning. Space flight experiment simulation facilities are under development and will be tested for their capability in supporting certain of the requirements for these investigations.

G.Y.

N79-21028#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**RECOMMENDATIONS OF THE PANELS: PANEL ON OZONE DESTRUCTION TECHNIQUES**

Ted Wydeven / In NASA. Lewis Res. Center Ozone Contamination in Aircraft Cabins Mar. 1979 p 9-10 (For primary document see N79-21011 12-03)

Avail: NTIS HC A05/MF A01 CSCL 06S

Catalyst materials to reduce weight, size, and cost of the ozone removal device were developed. Catalyst bed lifetime, competitive reactivity contaminants in the inlet air on the catalyst bed efficiency for ozone removal, and the kinetics and mechanism by which ozone is destroyed on selected catalysts were studied.

S.E.S.

N79-21352#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**THE 12TH AEROSPACE MECHANISMS SYMPOSIUM**

Apr. 1979 241 p refs Symp. held at Moffett Field, Calif.,  
27-28 Apr. 1978; sponsored in part by NASA, Calif. Inst. of  
Tech. and Lockheed  
(NASA-CP-2080; A-7737) Avail: NTIS HC A11/MF A01 CSCL 20K

Mechanisms developed for various aerospace applications are discussed. Specific topics covered include: boom release mechanisms, separation on space shuttle orbiter/Boeing 747 aircraft, payload handling, spaceborne platform support, and deployment of spaceborne antennas and telescopes. For individual titles, see N79-21353 through N79-21373.

L

N79-21741#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**COMPUTER PROGRAM FOR CALCULATION OF OXYGEN UPTAKE**

B. L. Castle, G. Castle, and J. E. Greenleaf Apr. 1979 13 p  
refs  
(NASA-TM-78585; A-7890) Avail: NTIS HC A02/MF A01  
CSCL 06P

A description and operational procedures are presented for a computer program, written in Super Basic, that calculates oxygen uptake, carbon dioxide production, and related ventilation parameters. Program features include: (1) the option of entering slope and intercept values of calibration curves for the O<sub>2</sub> and CO<sub>2</sub> and analyzers; (2) calculation of expired water vapor pressure; and (3) the option of entering inspired O<sub>2</sub> and CO<sub>2</sub> concentrations. The program is easily adaptable for programmable laboratory calculators.

Author

N79-25914#/ National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**PLANNING AND MANAGING FUTURE SPACE FACILITY PROJECTS**

Joan E. Sieber (California State Coll., Hayward), John A. Wilhelm  
(Texas Univ., Austin), Trieve A. Tanner, Robert L. Helmreich (Texas  
Univ., Austin), and Susan F. Burgenbach (Texas Univ., Austin)  
May 1979 29 p refs  
(NASA-TM-78586; A-7811) Avail: NTIS HC A03/MF A01  
CSCL 05A

To learn how ground-based personnel of a space project plan and organize their work and how such planning and organizing relate to work outcomes, longitudinal study of the management and execution of the Space Lab Mission Development Test 3 (SMD 3) was performed at NASA Ames Research Center. A

view of the problems likely to arise in organizations and some methods of coping with these problems are presented as well as the conclusions and recommendations that pertain strictly to SMD 3 management. Emphasis is placed on the broader context of future space facility projects and additional problems that may be anticipated. A model of management that may be used to facilitate problem solving and communication - management by objectives (MBO) is presented. Some problems of communication and emotion management that MBO does not address directly are considered. Models for promoting mature, constructive and satisfying emotional relationships among group members are discussed.

A.R.H.

**N79-21138\***# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**AN ADVANCED COCKPIT INSTRUMENTATION SYSTEM: THE COORDINATED COCKPIT DISPLAY**

D. L. Baty and M. L. Watkins (San Jose State Univ.) Jul 1979 22 p refs  
(NASA-TM-78559; A-7733) Avail: NTIS HC A02/MF A01 CSCL 01D

Cathode Ray Tube (CRT) and computer technologies are described in one approach to the replacement of flight instruments using three separate color CRT's. Each CRT display information pertinent to one of the three orthogonal projections of the aircraft flight situation. Three airline pilot's assessment of the display set is presented. Comments, rankings, and ratings show that the pilots accepted the concept of pictorial flight displays. S.E.S.

**N79-31316\***# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**EXPERIMENTAL CONTROL REQUIREMENTS FOR LIFE SCIENCES**

W. E. Berry and J. C. Sharp *In ESA Spacecraft Thermal and Environ. Control Systems* Oct 1978 p 467-472 (For primary document see N79-31266 22-18)  
Avail: NTIS HC A99/MF A01 CSCL 22B

The Life Sciences dedicated Spacelab will enable scientists to test hypotheses in various disciplines. Building upon experience gained in mission simulations, orbital flight test experiments, and the first three Spacelab missions, NASA will be able to progressively develop the engineering and management capabilities necessary for the first Life Sciences Spacelab. Development of experiments for these missions will require implementation of life-support systems not previously flown in space. Plant growth chambers, animal holding facilities, aquatic specimen life-support systems, and centrifuge-mounted specimen holding units are examples of systems currently being designed and fabricated for flight.

Author (ESA)

**N79-32185\***# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**COCKPIT DISPLAYS OF TRAFFIC INFORMATION: AIRLINE PILOTS OPINIONS ABOUT CONTENT, SYMBOLIC, AND FORMAT**

Sandra G. Hart (Tufts Univ., Medford, Mass.) and Thomas E. Wempe Aug 1979 54 p refs  
(NASA-TM-78601; A-7884) Avail: NTIS HC A04/MF A01 CSCL 17G

A number of candidate computer-generated cockpit displays of traffic information (CDTI) displays and display options were simulated statically and were shown to 23 airline pilots who were asked to respond to more than 250 questions about them. The pilots indicated that the amount and complexity of navigation information displayed should increase with altitude and map scale. Terrain information should appear automatically if a pilot's own aircraft descends below the minimum safe altitude and should include only those obstructions within 2,000 ft or less. Few pilots thought weather information should be displayed on a CDTI, but if it was, it should be at pilot request only. A chevron-shaped symbol, located so that the majority of the map area was ahead was preferred. The position, altitude, ground speed, ground track, weight class, and flightpath history of other aircraft should be

presented graphically by coding the shape of the symbol for other aircraft or presented digitally in data tags displayed at pilot request. All pilots thought that color coding was necessary to recognize different categories of information quickly and accurately. The majority of pilots felt that a CDTI would provide useful information even though its presence might increase their workload somewhat particularly during its introductory stages.

A.R.H.

**N79-32226\***# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**SPACE RESOURCES AND SPACE SETTLEMENTS**

John Billingham, ed., William Gilbreath, ed., Brian O'Leary, ed. (Princeton Univ.), and Beulah Gosset, ed. Washington 1979 292 p Derived from 1977 Ames Summer Study, Moffett Field, Calif. Original contains color illustrations  
(NASA-SP-428) Avail: NTIS MF A01: SOD HC CSCL 22B

The technical papers from the five tasks groups that took part in the 1977 Ames Summer Study on Space Settlements and Industrialization Using Nonterrestrial Materials are presented. The papers are presented under the following general topics: (1) research needs for regenerative life-support systems; (2) habitat design; (3) dynamics and design of electromagnetic mass drivers; (4) asteroids as resources for space manufacturing; and (5) processing of nonterrestrial materials. For individual titles, see N79-32226 through N79-32241.

**N79-32227\***# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**RESEARCH PLANNING CRITERIA FOR REGENERATIVE LIFE-SUPPORT SYSTEMS APPLICABLE TO SPACE HABITATS**

c15

Jack Spurlock (Georgia Inst. of Technol.), William Cooper (Michigan State Univ.), Paul Deal, Annita Harlan (Pima Coll.), Marcus Karel (MIT), Michael Modell (MIT), Paul Moe (Natl. Agr. Res. Center), John Phillips (Arizona Univ.), David Putnam (Umpqua Res. Co.), Philip Quattrone et al. *In its Space Resources and Space Settlements* 1979 p 13-30 refs (For primary document see N79-32225 23-12)

Avail: NTIS MF A01: SOD HC CSCL 22B

The second phase of analyses that were conducted by the Life Support Systems Group of the 1977 NASA Ames Summer Study is described. This phase of analyses included a preliminary review of relevant areas of technology that can contribute to the development of closed life-support systems for space habitats, the identification of research options in these areas of technology, and the development of guidelines for an effective research program. The areas of technology that were studied included: (1) nutrition, diet, and food processing; (2) higher plant agriculture; (3) animal agriculture; (4) waste conversion and resource recovery; and (5) system stability and safety. Results of these analyses, including recommended research options and criteria for establishing research priorities among these many options, are discussed.

G.Y.

**N79-33201\***# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**A REVIEW OF SOME HEAD-UP DISPLAY FORMATS**

J. M. Naish (NAS-NRC) Oct 1979 51 p refs  
(NASA-TP-1499; A-7708; HUD-4) Avail: NTIS HC A04/MF A01 CSCL 01D

Two alternate head-up display devices (HUD) were compared for properties relevant to the accurate performance of concurrent tasks in real flight conditions and in various flight modes. The comparisons were made to find the disorientation resistance of the HUDs along with the tracking accuracy, interference resistance, fixation resistance, and error resistance. The use of displacement and flight path information for vertical control is discussed in terms of flight stability. Several combinations of symbols and driving signals are described, including a compensated control law, which were used in simulated flight to deal with wind shear.

A.W.H.

## NASA CONTRACTOR REPORTS

N79-11883# Lockheed Missiles and Space Co., Sunnyvale, Calif.  
**VESTIBULAR FUNCTION RESEARCH (VFR) EXPERIMENT.**  
**PHASE B: DESIGN DEFINITION STUDY Final Report**  
24 May 1978 307 p  
(Contract NAS2-9781)  
(NASA-CR-152207; LMSC-E-626121) Avail: NTIS  
HC A14/MF A01 CSCL 06S

The Vestibular Functions Research (VFR) Experiment was established to investigate the neurosensory and related physiological processes believed to be associated with the space flight nausea syndrome and to develop logical means for its prediction, prevention and treatment. The VFR Project consists of ground and spaceflight experimentation using frogs as specimens. The phase B Preliminary Design Study provided for the preliminary design of the experiment hardware, preparation of performance and hardware specification and a Phase C/D development plan, establishment of STS (Space Transportation System) interfaces and mission operations, and the study of a variety of hardware, experiment and mission options. The study consist of three major tasks: (1) mission mode trade-off, (2) conceptual design, and (3) preliminary design. G.Y.

N79-16560# GARD, Inc., Niles, Ill.  
**FOUR-MAN RATED DUAL CATALYST SYSTEM FOR THE RECOVERY OF WATER FROM URINE Final Report**  
P. Budinikas Nov 1978 46 p  
(Contract NAS2-9715)  
(NASA-CR-152227) Avail: NTIS HC A03/MF A01 CSCL 06K

The catalytic system was integrated with a 4-man rated urine wick evaporator. During operation, urine vapor produced by the wick-evaporator was treated in the catalytic system to remove ammonia and volatile hydrocarbons, and water was recovered by condensation in a water cooled condenser. The system operated completely automatically and required no manual adjustments, except periodic supply of urine and removal of the recovered water. Although the system was designed for treating 0.325 kg urine per hour, this rate could be achieved only with a fresh wick, then gradually decreased as the wick became saturated with urine solids. The average urine treatment rates achieved during each of the three endurance tests were 0.137, 0.217, and 0.235 kg/hr. The quality of the recovered water meets drinking water standards, with the exception of a generally low pH. G.G.

N79-17494# Massachusetts Inst. of Tech., Cambridge.  
**MODELING HUMAN DECISION MAKING BEHAVIOR IN SUPERVISORY CONTROL** c63  
M. K. Tulga and T. B. Sheridan *In its Proc., 13th Ann. Conf. on Manual Control* 1977 p 199-209 refs (For primary document see N79-17475 08-51)  
(Grant NsG-2118)  
Avail: NTIS HC A20/MF A01 CSCL 09B

An optimal decision control model was developed, which is based primarily on a dynamic programming algorithm which looks at all the available task possibilities, charts an optimal trajectory, and commits itself to do the first step (i.e., follow the optimal trajectory during the next time period), and then iterates the calculation. A Bayesian estimator was included which estimates the tasks which might occur in the immediate future and provides this information to the dynamic programming routine. Preliminary trials comparing the human subject's performance to that of the optimal model show a great similarity, but indicate that the human skips certain movements which require quick change in strategy. J.M.S.

N79-17496# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THE HUMAN AS A DETECTOR OF CHANGES IN VARIANCE AND BANDWIDTH** c63  
Renwick E. Curry and T. Govindaraj (Ill. Univ., Urbana) *In MIT Proc., 13th Ann. Conf. on Manual Control* 1977 p 217-221 refs (For primary document see N79-17475 08-51)  
(Grant NGR 22-009-733)  
Avail: NTIS HC A20/MF A01 CSCL 05J

The detection of changes in random process variance and bandwidth was studied. Psychophysical thresholds for these two parameters were determined using an adaptive staircase technique for second order random processes at two nominal periods (1 and 3 seconds) and damping ratios (0.2 and 0.707). Thresholds for bandwidth changes were approximately 9% of nominal except for the (3sec,0.2) process which yielded thresholds of 12%. Variance thresholds averaged 17% of nominal except for the (3sec,0.2) process in which they were 32%. Detection times for suprathreshold changes in the parameters may be roughly described by the changes in RMS velocity of the process. A more complex model is presented which consists of a Kalman filter designed for the nominal process using velocity as the input, and a modified Wald sequential test for changes in the variance of the residual. The model predictions agree moderately well with the experimental data. Models using heuristics, e.g. level crossing counters, were also examined and are found to be descriptive but do not afford the unification of the Kalman filter/sequential test model used for changes in mean. J.M.S.

N79-17497# Massachusetts Inst. of Tech., Cambridge.  
**A QUEUING MODEL OF PILOT DECISION MAKING IN A MULTI-TASK FLIGHT MANAGEMENT SITUATION** c63  
R. S. Walden and W. B. Rouse *In its Proc., 13th Ann. Conf. on Manual Control* 1977 p 222-236 refs (For primary document see N79-17475 08-51)  
(Grant NsG-2119)

Avail: NTIS HC A20/MF A01 CSCL 09B  
Allocation of decision making responsibility between pilot and computer is considered and a flight management task, designed for the study of pilot-computer interaction, is discussed. A queuing theory model of pilot decision making in this multi-task, control and monitoring situation is presented. An experimental investigation of pilot decision making and the resulting model parameters are discussed. Author

N79-17498# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**INTERRUPTED MONITORING OF A STOCHASTIC PROCESS** c65  
Everett Palmer *In MIT Proc., 13th Ann. Conf. on Manual Control* 1977 p 237-244 refs (For primary document see N79-17475 08-51)  
Avail: NTIS HC A20/MF A01 CSCL 12A

Normative strategies are developed for tasks where the pilot must interrupt his monitoring of a stochastic process in order to attend to other duties. Results are given as to how characteristics of the stochastic process and the other tasks affect the optimal strategies. The optimum strategy is also compared to the strategies used by subjects in a pilot experiment. J.M.S.

N79-17499# Tufts Univ., Medford, Mass.  
**AIR TRAFFIC CONTROL BY DISTRIBUTED MANAGEMENT IN A MLS ENVIRONMENT** c65  
J. G. Kreifeldt, L. Parkin, and S. Hart (San Jose State Univ.) *In MIT Proc., 13th Ann. Conf. on Manual Control* 1977 p 246-257 refs (For primary document see N79-17475 08-51)  
(Grant NsG-2156)  
Avail: NTIS HC A20/MF A01 CSCL 17G

The microwave landing system (MLS) is a technically feasible means for increasing runway capacity since it could support curved approaches to a short final. The shorter the final segment of the approach, the wider the variety of speed mixes possible so that theoretically, capacity would ultimately be limited by

runway occupancy time only. An experiment contrasted air traffic control in a MLS environment under a centralized form of management and under distributed management which was supported by a traffic situation display in each of the 3 piloted simulators. Objective flight data, verbal communication and subjective responses were recorded on 18 trial runs lasting about 20 minutes each. The results were in general agreement with previous distributed management research. In particular, distributed management permitted a smaller spread of intercrossing times and both pilots and controllers perceived distributed management as the more 'ideal' system in this task. It is concluded from this and previous research that distributed management offers a viable alternative to centralized management with definite potential for dealing with dense traffic in a safe, orderly and expeditious manner.

L.S.

N79-17501# Tufts Univ., Medford, Mass. Dept. of Engineering Design.

**DESIGN OUTLINE FOR A NEW MULTIMAN ATC SIMULATION FACILITY AT NASA-AMES RESEARCH CENTER**

J. G. Kreifeldt and O. Gallagher /n MIT Proc., 13th Ann. Conf. on Manual Control 1977 p 266-271 refs (For primary document see N79-17475 08-51)  
(Grant NSG-2156)

Avail: NTIS HC A20/MF A01 CSCL 14B

A new and unique facility for studying human factors aspects in aerodynamics is being planned for use in the Man-Vehicle Systems Research Division at the NASA-Ames Research Center. This facility will replace the existing three cockpit-single ground controller station and be expandable to include approximately seven cockpits and two ground controller stations. Unlike the previous system, each cockpit will be mini-computer centered and linked to a main CPU to effect a distributed computation facility. Each simulator will compute its own flight dynamic and flight path predictor. Mechanical flight instruments in each cockpit will be locally supported and CRT cockpit displays of (e.g.) traffic and or RNAV information will be centrally computed and distributed as a means of extending the existing computational and graphical resources. An outline of the total design is presented which addresses the technical design options and research possibilities of this unique man-machine facility and which may also serve as a model for other real time distributed simulation facilities.

L.S.

N79-17508# SRI International Corp., Menlo Park, Calif.  
**TWO MEASURES OF PERFORMANCE IN A PEG-IN-HOLE MANIPULATION TASK WITH FORCE FEEDBACK**

c63

John W. Hill /n MIT Proc., 13th Ann. Conf. on Manual Control 1977 p 301-309 refs (For primary document see N79-17475 08-51)

(Contract NAS2-8652)

Avail: NTIS HC A20/MF A01 CSCL 05J

The results are described from two manipulators on a peg-in-hole task, which is part of a continued effort to develop models for human performance with remote manipulators. Task difficulty is varied by changing the diameter of the peg to be inserted in a 50 mm diameter hole. An automatic measuring system records the distance between the tool being held by the manipulator and the receptacle into which it is to be inserted. The data from repeated insertions are processed by computer to determine task times, accumulated distances, and trajectories. Experiments with both the MA-11 cable-connected master-slave manipulator common to hot cell work and the MA-23 servo-controlled manipulator (with and without force feedback) are described. Comparison of these results with previous results of the Ames Manipulator shows that force feedback provides a consistent advantage.

L.S.

N79-17519# National Aeronautics and Space Administration  
Ames Research Center, Moffett Field, Calif.

**SPEECH AS A PILOT INPUT MEDIUM**

c64

R. P. Plummer (Utah Univ.) and C. R. Coler /n MIT Proc.

13th Ann. Conf. on Manual Control 1977 p 460-462 refs  
(For primary document see N79-17475 08-51)

(Grant NGR-45-003-108)

Avail: NTIS HC A20/MF A01 CSCL 05H

The speech recognition system under development is a trainable pattern classifier based on a maximum-likelihood technique. An adjustable uncertainty threshold allows the rejection of borderline cases for which the probability of misclassification is high. The syntax of the command language spoken may be used as an aid to recognition, and the system adapts to changes in pronunciation if feedback from the user is available. Words must be separated by .25 second gaps. The system runs in real time on a mini-computer (PDP 11/10) and was tested on 120,000 speech samples from 10- and 100-word vocabularies. The results of these tests were 99.9% correct recognition for a vocabulary consisting of the ten digits, and 99.8% recognition for a 100-word vocabulary of flight commands, with a 5% rejection rate in each case. With no rejection, the recognition accuracies for the same vocabularies were 99.5% and 98.6% respectively.

L.S.

N79-21033# Massachusetts Inst. of Tech., Cambridge. Lab. for Information and Decision Systems.

**SIMULATION EVALUATION OF COMBINED 4D RNAV AND AIRBORNE TRAFFIC SITUATION DISPLAYS AND PROCEDURES APPLIED TO TERMINAL AERIAL MANEUVERS**

Semi-annual Progress Report, 1 Sep. 1978 - 1 Mar. 1979

Michael Athans and Mark E. Connolly 1 Mar. 1979 44 p

(Grant NGR-2180)  
(NASA-CR-158474) Avail: NTIS HC A03/MF A01 CSCL 17G

Simulation scenarios were developed in which subject pilots must simultaneously follow a 3D terminal airspace structure and arrive at fixed waypoints within the structure precisely at pre-scheduled times in the presence of a full range of wind conditions aloft, and monitor nearby traffic on an airborne traffic situation display, especially during merging and spacing operations, and detect blunders and resolve conflicts in a safe manner. Open-loop simulator tests of the single-stage 4D RNAV algorithm indicate that a descending pilot can comply quite closely with an assigned time of arrival at a 3D waypoint simply by tracking a pre-calculated speed profile. Initial experiments show that the aircraft arrives at the 3D waypoint within a few seconds of the anticipated time. The presence of headwinds or tailwinds does not affect the arrival time error as long as the wind is accurately modeled in the descent algorithm. Results all but guarantee that a 5 second standard deviation in arrival time error can be realized in closed-loop descents at very moderate pilot workload levels.

A.R.H.

N79-25704# Florida Agricultural and Mechanical Univ., Tallahassee. School of Pharmacy.

**MICROBIAL TRANSFORMATION OF NUCLEOSIDES** Final Report

S. S. Lamba 1979 17 p

(Grant NSG-2103)

(NASA-CR-158696) Avail: NTIS HC A02/MF A01 CSCL 06C

A study involving the use of coulter counter in studying the effects of neomycin on *E. coli*, *S. aureus* and *A. aerogenes* was completed. The purpose of this was to establish proper technique for enumeration of cells per ml. It was found that inhibitory effects on growth of *E. coli* and *A. aerogenes*, both gram negative organisms, were directly related to the concentration of neomycin used. However, in case *S. aureus*, a gram positive organism, a decreased inhibition was noted at higher concentrations. A paper entitled, Use of Coulter Counter in Studying Effect of Drugs on Cells in Culture 1 - Effects of Neomycin on *E. coli*, *S. aureus* and *A. aerogenes*, is attached in the appendix. Laboratory procedures were also established to study the effects of nucleoside antibiotic cordycepin on He La cell grown in suspension cultures.

G.Y.

N79-28135# Life Systems, Inc., Cleveland, Ohio.

**TECHNOLOGY ADVANCEMENT OF THE ELECTROCHEMICAL CO<sub>2</sub> CONCENTRATING PROCESS Final Report, Feb. 1975 - Mar. 1979**

F. H. Schubert, D. B. Heppner, T. M. Hallick, and R. R. Woods  
May 1979 125 p refs  
(Contract NAS2-8666)

(NASA-CR-152250; LSI-ER-258-7) Avail: NTIS  
HC A06/MF A01 CSCL 07D

Two multicell, liquid-cooled, advanced electrochemical depolarized carbon dioxide concentrator modules were fabricated. The cells utilized advanced, lightweight, plated anode current collectors, internal liquid cooling and lightweight cell frames. Both were designed to meet the carbon dioxide removal requirements of one-person, i.e., 1.0 kg/d (2.2 lb/d). M.M.M.

N79-28880# Massachusetts Inst. of Tech., Cambridge. Dept. of Nutrition and Food Science.

**MAXIMIZING STORAGE STABILITY OF FOODS TO BE USED FOR RESUPPLY IN A CONTROLLED ECOLOGICAL LIFE SUPPLY SYSTEM: EVALUATION OF RESEARCH**

M. Karel, I. Saguy, R. Villota, and H. D. Heidelbaugh Jul. 1979 187 p refs  
(Grant NsG-2334)

(NASA-CR-158846) Avail: NTIS HC A09/MF A01 CSCL 06H

The state of the art and research needs of storage stability of dehydrated foods were evaluated. A critical literature review is also included R.E.S.

N79-28883# Life Systems, Inc., Cleveland, Ohio.

**TECHNOLOGY ADVANCEMENT OF AN OXYGEN GENERATION SUBSYSTEM Final Report**

M. K. Lee, K. A. Burke, F. H. Schubert, and R. A. Wynveen May 1979 78 p refs  
(Contract NAS2-9795)

(NASA-CR-152257; LSI-ER-336-4) Avail: NTIS  
HC A05/MF A01 CSCL 06K

An oxygen generation subsystem based on water electrolysis was developed and tested to further advance the concept and technology of the spacecraft air revitalization system. Emphasis was placed on demonstrating the subsystem integration concept and hardware maturity at a subsystem level. The integration concept of the air revitalization system was found to be feasible. Hardware and technology of the oxygen generation subsystem was demonstrated to be close to the preprototype level. Continued development of the oxygen generation technology is recommended to further reduce the total weight penalties of the oxygen generation subsystem through optimization. R.E.S.

N79-29794# Life Systems, Inc., Cleveland, Ohio.

**ELECTROCHEMICALLY REGENERABLE CARBON DIOXIDE ABSORBER Final Report**

R. R. Woods, R. D. Marshall, F. H. Schubert, and D. B. Heppner Aug 1979 63 p refs  
(Contract NAS2-8666)

(NASA-CR-152099; LSI-ER-290-3) Avail: NTIS  
HC A04/MF A01 CSCL 06K

Preliminary designs were generated for two electrochemically regenerable carbon dioxide absorber concepts. Initially, an electrochemically regenerable absorption bed concept was designed. This concept incorporated the required electrochemical regeneration components in the absorber design, permitting the absorbent to be regenerated within the absorption bed. This hardware was identified as the electrochemical absorber hardware. The second hardware concept separated the functional components of the regeneration and absorption process. This design approach minimized the extravehicular activity component volume by eliminating regeneration hardware components within the absorber. The electrochemical absorber hardware was extensively characterized for major operating parameters such as inlet carbon dioxide partial pressure, process air flow rate, operational pressure, inlet relative humidity, regeneration current density and absorption/regeneration cycle endurance testing. R.E.S.

N79-33881# San Jose State Univ. Foundation, Calif.

**THE ROLE OF COGNITIVE SWITCHING IN HEAD-UP DISPLAYS**

Edith Fischer May 1979 49 p refs  
(Grant NsG-2269)  
(NASA-CR-3137; A-7776; HUD-5) Avail: NTIS  
HC A03/MF A01 CSCL 01D

The pilot's ability to accurately extract information from either one or both of two superimposed sources of information was determined. Static, aerial, color 35 mm slides of external runway environments and slides of corresponding static head-up display (HUD) symbology were used as the sources. A three channel tachistoscope was utilized to show either the HUD alone, the scene alone, or the two slides superimposed. Cognitive performance of the pilots was assessed by determining the percentage of correct answers given to two HUD related questions, two scene related questions, or one HUD and one scene related question. A.W.H.

X79-10127# Naval Air Development Center, Warminster, Pa.

**PROCEEDINGS: VOICE TECHNOLOGY FOR INTERACTIVE REAL-TIME COMMAND/CONTROL SYSTEMS APPLICATION**

Robert Breaux, ed., Mike Curran, ed., and Edward M. Huff, ed. 1977 355 p refs Symp.-Workshop held at Moffett Field, Calif. 6-8 Dec. 1977 Prepared in cooperation with NASA Ames Res. Center, and Naval Training Equipment Center, Orlando, Fla.

(NASA-CR-152283) Avail: Commander Mike Curran Ph.D (USN) Superintendent, Human Factors Eng Div (602), Aircraft and Crew Systems Technol. Directorate, Naval Air Develop. Center, Warminster, Pa. 18974 Unclassified report

NOTICE Available to U.S. Government Agencies.

Speech understanding among researchers and managers, current developments in voice technology, and an exchange of information concerning government voice technology efforts are discussed. For individual titles, see X79-10128 through X79-10144.

X79-10135# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**AUTOMATIC SPEECH RECOGNITION RESEARCH AT NASA-AMES RESEARCH CENTER**

Clayton R. Coler, Robert R. Plummer (Utah Univ.), Edward M. Huff, and Myron H. Hitchcock (Computer Sci. Corp., Mountain View, Calif.) In Naval Air Develop. Center Proc. Voice Technol. for Interactive Real-Time Command/Control Systems Appl. 1977 p 143-170 refs (For primary document see X79-10127 Cat. 32) Avail: Commander Mike Curran Ph.D (USN) Superintendent, Human Factors Eng. Technol. Directorate, Naval Air Develop. Center, Warminster, Pa. 18974 Unclassified report

NOTICE Available to U.S. Government Agencies.

A trainable acoustic pattern recognizer manufactured by Scope Electronics is presented. The voice command system VCS encodes speech by sampling 16 bandpass filters with center frequencies in the range from 200 to 5000 Hz. Variations in speaking rate are compensated for by a compression algorithm that subdivides each utterance into eight subintervals in such a way that the amount of spectral change within each subinterval is the same. The recorded filter values within each subinterval are then reduced to a 15-bit representation, giving a 120-bit encoding for each utterance. The VCS incorporates a simple recognition algorithm that utilizes five training samples of each word in a vocabulary of up to 24 words. The recognition rate of approximately 85 percent correct for untrained speakers and 94 percent correct for trained speakers was not considered adequate for flight systems use. Therefore, the built-in recognition algorithm was disabled, and the VCS was modified to transmit 120-bit encodings to an external computer for recognition. M.M.M.

## JOURNAL ARTICLES, BOOKS AND CHAPTERS OF BOOKS

A79-10425 \* Coupling of aspartate and serine transport to the transmembrane electrochemical gradient for sodium ions in *Halobacterium halobium* - Translocation stoichiometries and apparent cooperativity. J. K. Lanyi (NASA, Ames Research Center, Extraterrestrial Biology Div., Moffett Field, Calif.). *Biochemistry*, vol. 17, no. 15, 1978, p. 3011-3018. 42 refs.

A79-10608 \* In-vivo bone strain telemetry in monkeys /M. nemestrina/. D. R. Young, W. H. Howard (NASA, Ames Research Center, Moffett Field, Calif.), and D. Orne (Wayne State University, Detroit, Mich.). *ASME, Transactions, Journal of Biomechanical Engineering*, vol. 99, May 1977, p. 104-109. 10 refs.

A new method for collecting in-vivo bone strain data in monkeys has been developed and tested. The method includes a system which consists of a new design of implantable strain transducer and its companion telemetry package. The transducer fits into a hole drilled in a monkey tibia and is threaded for subsequent bone ingrowth. The transducers and telemetry package are biocompatible for over 503 days. The telemetry package uses Pulse Interval Ratio Modulation (PIRM) to transmit strain information to receiving equipment located outside the animal housing cage. (Author)

A79-11224 \* Biological specimen holding facilities for Spacelab experiments. J. K. Jackson, M. M. Yakut, G. L. Murphy (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.), and W. Berry (NASA, Ames Research Center, Moffett Field, Calif.). *International Astronautical Federation, International Astronautical Congress, 29th, Dubrovnik, Yugoslavia, Oct. 1-8, 1978, Paper 78-56*. 15 p. (MDAC-WD-2857)

The paper describes the design, development, integration, and testing of two prototype holding facilities: (1) a unit housing 36 laboratory rats in individual cages, and (2) a unit housing one unrestrained 14-kg rhesus monkey. Both units are environmentally controlled enclosures complete with food, water, and waste-collection equipment. Timer-controlled fluorescent lights in both units permit automatic day-night cycling. Both units are designed to be compatible with Spacelab interfaces and to be operated by NASA payload specialists. B.J.

A79-11309 \* Organic chemistry in space. R. D. Johnson (NASA, Ames Research Center, Biosystems Div., Moffett Field, Calif.). *Chemistry*, vol. 50, Oct. 1977, p. 17-22. 10 refs.

Organic cosmochemistry, organic materials in space exploration, and biochemistry of man in space are briefly surveyed. A model of Jupiter's atmosphere is considered, and the search for organic molecules in the solar system and in interstellar space is discussed. Materials and analytical techniques relevant to space exploration are indicated, and the blood and urine analyses performed on Skylab are described. M.L.

A79-11947 \* Comparison of circadian rhythms in male and female humans. C. M. Winget, C. W. DeRoshia, J. Vernikos-Danellis (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.), W. S. Rosenblatt, and N. W. Hetherington (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Geneticon, Walnut Creek, Calif.). *Waking and Sleeping*, vol. 1, 1977, p. 359-363. 9 refs.

Heart rate (HR) and rectal temperature (RT) data were obtained from 12 female and 27 male subjects. The subjects were housed in a facility where the environment was controlled. Human male and female RT and HR exhibit a circadian rhythm with an excursion of

about 1.2°C and 30 beats/min, respectively. The acrophases, amplitudes, and level crossings are only slightly different between the sexes. The male HR and RT circadian wave forms are more stable than those of the females. However, the actual RT and HR of males were always lower than that of females at all time points around the clock. The HR during sleep in females is 15 per cent below the daily mean heart rate and in males, 22 per cent. (Author)

A79-11948 \* Comparison of hormone and electrolyte circadian rhythms in male and female humans. J. Vernikos-Danellis, C. M. Winget, A. E. Goodwin, and T. Reilly (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Waking and Sleeping*, vol. 1, 1977, p. 365-368. 16 refs.

Circadian rhythm characteristics in healthy male and female humans were studied at 4-hour intervals for urine volume, cortisol, 5-hydroxyindoleacetic acid (5-HIAA), Na, K, Na/K ratios in the urine, as well as plasma cortisol. While plasma and urinary cortisol rhythms were very similar in both sexes, the described rhythms in urine volume, electrolyte, and 5-HIAA excretion differ for the two sexes. The results suggest that sex differences exist in the circadian patterns of important hormone and metabolic functions and that the internal synchrony of circadian rhythms differs for the two sexes. The results seem to indicate that the rhythmical secretion of cortisol does not account for the pattern of Na and K excretion. M.L.

A79-11950 \* Characterization of a novel extremely alkaliphilic bacterium. K. A. Souza and P. H. Deal (NASA, Ames Research Center, Biological Adaptation Branch, Moffett Field, Calif.). *Journal of General Microbiology*, vol. 101, 1977, p. 103-109. 20 refs.

A new alkaliphilic bacterium, isolated from a natural spring of high pH is characterized. It is a Gram-positive, non-sporulating, motile rod requiring aerobic and alkaline conditions for growth. The characteristics of this organism resemble those of the coryneform group of bacteria; however, there are no accepted genera within this group with which this organism can be closely matched. Therefore, a new genus may be warranted. (Author)

A79-12123 \* A study of axonal degeneration in the optic nerves of aging mice. J. E. Johnson, Jr., D. E. Philpott, and J. Miquel (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Age*, vol. 1, Apr. 1978, p. 50-55. 38 refs.

The optic nerves of C57BL/6J mice ranging from 3 to 30 months were examined by electron microscopy. At all ages investigated, optic nerve axons contained enlarged mitochondria with abnormal cristae. With increasing age, a large number of necrotic axons were observed and were in the process of being phagocytized. The abnormal mitochondria may represent preliminary changes that eventually lead to necrosis of the axon. (Author)

A79-12400 \* In vivo response of ornithine  $\alpha$ -carboxylase activity to growth hormone as demonstrated by oxidation of L-ornithine-1-C-14/ in hypophysectomized rats. D. D. Feller, E. D. Neville, and S. Ellis (NASA, Ames Research Center, Moffett Field, Calif.). *Physiological Chemistry and Physics*, vol. 9, no. 1, 1977, p. 55-61. 6 refs.

A79-12474 \* Effects of fenfluramine administration on activity of the pituitary-adrenal system in the rat. J. P. Heybach and J. Vernikos-Danellis (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Western Pharmacology Society, Proceedings*, vol. 21, 1978, p. 19-25. 6 refs.

A79-12475 \* Temperature-dependent morphological changes in membranes of *Bacillus stearothermophilus*. C. A. Halverson, A. F. Esser (California State University, Fullerton, Calif.), and K. A. Souza (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Supramolecular Structure*, vol. 8, 1978, p. 129-138. 27 refs. Research supported by the Research Corp.; Grant No. NA2 OR253-601.

A79-12509 \* Observational program options and system requirements for the search for extraterrestrial intelligence. J. Billingham, J. H. Wolfe (NASA, Ames Research Center, Moffett Field, Calif.), R. E. Edelson, S. Gulkis (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), and S. R. Sadin (NASA, Washington, D.C.). In: *Life sciences and space research XVI*, Proceedings of the Open Meetings of the Working Group on Space Biology, Tel Aviv, Israel, June 7-18, 1977. (A79-12508 02-51) Oxford, Pergamon Press, Ltd., 1978, p. 17-30. 23 refs.

The possibility that intelligent life may be widespread in the universe is now being investigated. A formula for estimating the number of coexisting communicative civilizations has been developed by Drake. A good way of conducting a search for extraterrestrial intelligence (SETI) is to examine the microwave window of the electromagnetic spectrum for narrow-band signals which such civilizations may be transmitting. Two specific search strategies are described. Both employ existing antennas equipped with sophisticated multichannel spectrum analyzers and pattern recognition devices. The Ames Research Center proposal is a high sensitivity, high-resolution search of nearby promising stars and selected sky areas in the 'water hole' (1400-1727 MHz). The Jet Propulsion Laboratory proposal is for a survey of most of the sky over a significant portion of the free-space microwave window at lower sensitivities and resolutions. These approaches are complementary and both are being pursued. The consummation of these programs could achieve one of the most profound discoveries in the history of human civilization, or at least will show the way to future efforts.

(Author)

A79-12511 \* Planetary protection guidelines for Outer Planet missions. P. Stabekis (Exotech Research and Analysis, Inc., Gaithersburg, Md.) and D. L. DeVincenzi (NASA, Ames Research Center, Moffett Field, Calif.). In: *Life sciences and space research XVI*, Proceedings of the Open Meetings of the Working Group on Space Biology, Tel Aviv, Israel, June 7-18, 1977 (A79-12508 02-51) Oxford, Pergamon Press, Ltd., 1978, p. 39-44. 8 refs.

Facilities, techniques, and operational procedures used to implement Planetary Protection (PP) requirements for the Viking Project are reviewed in order to better define the COSPAR resolution which proposes that Outer Planet spacecraft be assembled using Viking-like clean room technology. It is concluded that, for such missions, PP requirements can be met by adopting Viking clean room standards, personnel and operation procedures, and by establishing PP as an official entity in project management.

(Author)

A79-12552 \* Water electrolysis system - H<sub>2</sub> and O<sub>2</sub> generation. F. H. Schubert, M. K. Lee, R. J. Davenport (Life Systems, Inc., Cleveland, Ohio), and P. D. Quattrone (NASA, Ames Research Center, Moffett Field, Calif.). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems*, San Diego, Calif., July 10-13, 1978, Paper 78-ENAs-3. 12 p. 11 refs. Members, \$1.50, nonmembers, \$3.00.

An oxygen generation system design based on the static feed water electrolysis concept is described. The system is designed to generate 4.20 kg/d of oxygen to satisfy the metabolic needs of a three person crew, to compensate for spacecraft leakage, and to provide the oxygen required by the electrochemical depolarized CO<sub>2</sub> concentrator. The system has a fixed hardware weight of 75 kg, occupies a volume of 0.11 cu m, and requires only 1.1 kw of electrical power. The static feed electrolysis concept is discussed, and

experimental data on the high-performance electrode are presented.

M.L.

A79-12559 \* Animal life support transporters for Shuttle/Spacelab. W. E. Berry (NASA, Ames Research Center, Moffett Field, Calif.) and S. R. Hunt (General Electric Co., Philadelphia, Pa.). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems*, San Diego, Calif., July 10-13, 1978, Paper 78-ENAs-10. 8 p. Members, \$1.50, nonmembers, \$3.00.

Two transporter devices have been developed by the NASA Ames Research Center, primarily for the purpose of stowing small vertebrates and primates in the mid-deck avionics bay of the Shuttle during launch and re-entry. These animals will be used in Life Science Spacelab experiments. Stowage in the mid-deck area will reduce animal exposure to the high noise levels existing in Spacelab during launch; further, the possible exposure of the animals to high temperatures in Spacelab during re-entry and post landing will be eliminated. The transporters will provide experimenters more timely access to their animals during experiment critical, pre-launch, and post-landing periods. Rechargeable batteries in the transporters will provide life support system functions for the animals during periods of transfer and during mission phases in which power is temporarily unavailable. The transporters have been successfully designed, fabricated, and tested. Integrated testing of the transporters was performed in the Space Mission Development III (SMD III) Simulation at the NASA Johnson Space Center.

(Author)

A79-12574 \* Vestibular Function Research aboard Spacelab. R. W. Mah and N. G. Daunton (NASA, Ames Research Center, Life Sciences Directorate, Moffett Field, Calif.). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems*, San Diego, Calif., July 10-13, 1978, Paper 78-ENAs-25. 8 p. Members, \$1.50, nonmembers, \$3.00.

NASA is planning to perform a series of Vestibular Function Research (VFR) investigations on the early STS missions to investigate those neurosensory and related physiological processes believed to be associated with the space flight nausea syndrome. The first flight is scheduled for the 1981 Spacelab III Mission in which four frog specimens, mounted on a frog tilting/centrifuge device, will be subjected to periodic acceleration stimuli and periods of artificial gravity. The vestibular nerve firing responses of each frog specimen will be monitored through implanted neutral buoyancy micro electrodes and transmitted to the ground for quick analysis during the flight. The experimentation will be directed at investigating: (1) adaptation to weightlessness, (2) response to acceleration stimuli, (3) response to artificial gravity (in a weightlessness environment) and (4) readaptation to earth's gravity upon return.

(Author)

A79-12584 \* Support system considerations for STS biological investigations. G. H. Bowman (Technology, Inc., Mountain View, Calif.) and P. D. Sebesta (NASA, Ames Research Center, Biosystems Div., Moffett Field, Calif.). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems*, San Diego, Calif., July 10-13, 1978, Paper 78-ENAs-37. 6 p. 11 refs. Members, \$1.50, nonmembers, \$3.00.

Equipment required for Space Transportation System biological experiments is considered, and environmental factors and operational constraints affecting the performance of experiments are examined. Specimen housing is discussed, problems associated with telemetry procedures are characterized, and attention is directed to the problems of handling hazardous fixatives, radioisotopes, and chemicals.

M.L.

A79-12587 \* Instrumentation for controlling and monitoring environmental control and life support systems. P. Y. Yang, J.

R. Gyorki, and R. A. Wynveen (Life Systems, Inc., Cleveland, Ohio). *American Society of Mechanical Engineers, Intersociety Conference on Environmental Systems, San Diego, Calif., July 10-13, 1978, Paper 78-ENAS-40*. 14 p. 14 refs. Members, \$1.50; nonmembers, \$3.00. Contracts No. NAS2-9251; No. NAS2-8666, No. NAS9-15218; No. NAS9-15267; Grant No. DAMD17-76-C-6063.

Advanced instrumentation concepts for improving performance of manned spacecraft Environmental Control and Life Support Systems (EC/LSS) have been developed at Life Systems, Inc. The difference in specific EC/LSS instrumentation requirements and hardware during the transition from exploratory development to flight production stages are discussed. Details of prior control and monitor instrumentation designs are reviewed and an advanced design presented. The latter features a minicomputer-based approach having the flexibility to meet process hardware test programs and the capability to be refined to include the control dynamics and fault diagnostics needed in future flight systems where long duration, reliable operation requires in-flight hardware maintenance. The emphasis is on lower EC/LSS hardware life cycle costs by simplicity in instrumentation and using it to save crew time during flight operation.  
(Author)

**A79-12869 \*** *Studies on the erythron and the ferrokinetic responses in beagles adapted to hypergravity.* D. A. Beckman, J. W. Evans (California, University, Davis, Calif.), and J. Oyama (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, California, University, Davis, Calif.). *Aviation, Space, and Environmental Medicine*, vol. 49, Nov. 1978, p. 1331-1336. 23 refs. Grant No. NCA2-OR180-505.

Red cell survival, ferrokinetics, and hematologic parameters were investigated in beagle dogs exposed to chronic hypergravity (2.6 Gx). Ineffective erythropoiesis, red cell mass, plasma volume, and Cr-51-elution were significantly increased; maximum Fe-59 incorporation was decreased, and there was no change in the mean erythrocyte life span following autologous injection of Cr-51-labeled red cells and Fe-59-labeled transferrin. Red cell count, Hct, total body hemoglobin (Hb), susceptibility to osmotic lysis, and differential reticulocyte count were increased. White blood cell count, venous blood %Hb, mean cell volume, mean cell Hb, mean cell Hb concentration, and serum iron were decreased. No changes were observed for body mass, mg Fe per g Hb, iron binding capacity, percent saturation of iron carrying capacity, or the electrophoretic mobility of purified Hb. This study indicated that chronic exposure to hypergravity induced changes in red cell size, volume, total mass, and membrane permeability.  
(Author)

**A79-13219 \*** *Coordinated crew performance in commercial aircraft operations.* M. R. Murphy (NASA, Ames Research Center, Moffett Field, Calif.). In: *Human Factors Society, Annual Meeting, 21st, San Francisco, Calif., October 17-20, 1977, Proceedings*. (A79-13181 03-54) Santa Monica, Calif., Human Factors Society, Inc., 1977, p. 416-420. 22 refs.

A specific methodology is proposed for an improved system of coding and analyzing crew member interaction. The complexity and lack of precision of many crew and task variables suggest the usefulness of fuzzy linguistic techniques for modeling and computer simulation of the crew performance process. Other research methodologies and concepts that have promise for increasing the effectiveness of research on crew performance are identified.  
B.J.

**A79-13349 \*** *A structure suitable for implementing digital filters with poles near  $z = +1$ .* A. I. Abu-El-Haija, K. Shenoi, and A. M. Peterson (Stanford University, Stanford, Calif.). In: *NTC '77; National Telecommunications Conference, Los Angeles, Calif., December 5-7, 1977, Conference Record, Volume 2*. (A79-13301 03-32) New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 29:5-1 to 29:5-7. 17 refs. Grants No. NGL-05-020-014, No. NSG-2121; No. NCA2-OR745-614; Contract No. N00014-75-C-0601.

Errors limiting the application of recursive digital filters which have poles near  $z = +1$  are considered, and a filter structure for pole locations close to  $z = +1$  is proposed. The filter structure, based on digital incremental computers, has low sensitivity and good error characteristics for pole locations near  $z = +1$ . Expressions for the roundoff error are derived, and errors associated with the proposed structure and a conventional structure are compared. A design procedure is suggested for implementing the new filter structure when the transfer function is given. Simulation results are presented.  
M.L.

**A79-17657 \* #** *Spacelab mission development tests.* B. P. Dalton (NASA, Ames Research Center, Moffett Field, Calif.). In: *Aerospace Testing Seminar, 4th, Los Angeles, Calif., March 2, 3, 1978, Proceedings*. (A79-17651 05-12) Mt. Prospect, Ill., Institute of Environmental Sciences, 1978, p. 43-49; Discussion, p. 50.

The paper describes Spacelab Mission Development Test III (SMD III) whose principal scientific objective was to demonstrate the feasibility of conducting biological research in the Life Sciences Spacelab. The test also provided an opportunity to try out several items of Common Operational Research Equipment (CORE) hardware being developed for operational use in Shuttle/Spacelab, such as rodent and primate handling, transportation units, and a 'zero-g' surgical bench. Operational concepts planned for Spacelab were subjected to evaluation, including animal handling procedures, animal logistics, crew selection and training, and a 'remote' ground station concept. It is noted that all the objectives originally proposed for SMD III were accomplished.  
B.J.

**A79-18598 \*** *Stereochemistry of amino acids in surface samples of a marine sediment.* G. E. Pollock (NASA, Ames Research Center, Moffett Field, Calif.) and K. A. Kvenvolden (U.S. Geological Survey, Menlo Park, Calif.). *Geochimica et Cosmochimica Acta*, vol. 42, Dec. 1978, p. 1903-1905. 12 refs.

In two surface samples of marine sediment, the percentages of D-alanine and D-aspartic acid are significantly higher than the other D-amino acids and are similar to the range found in soils. The percentage of D-glutamic acid is also higher than the other amino acids but less than D alanine and D-aspartic acid. These D-amino acids may come mainly from bacteria.  
(Author)

**A79-19449 \*** *Identification of a tripeptidyl aminopeptidase in the anterior pituitary gland - Effect on the chemical and biological properties of rat and bovine growth hormones.* T. W. Doeberl, A. R. Divor, and S. Ellis (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Endocrinology*, vol. 103, no. 5, 1978, p. 1794-1804. 21 refs.

**A79-20016 \* #** *Experimental evaluation of a wind shear alert and energy management display.* K.-F. Kraiss (Forschungsinstitut für Anthropotechnik Meckenheim, West Germany) and D. L. Baty (NASA, Ames Research Center, Moffett Field, Calif.). *Deutsche Gesellschaft für Luft- und Raumfahrt und Hermann-Oberth-Gesellschaft, Deutscher Luft- und Raumfahrtkongress, Darmstadt, West Germany, Sept. 19-23, 1978, DGLR Paper 78-153*, 29 p. 5 refs.

A method is proposed for onboard measurement and display of specific windshear and energy management data derived from an air data computer. An open-loop simulation study is described which was carried out to verify the feasibility of this display concept, and whose results were used as a basis to develop the respective cockpit instrumentation. The task was to fly a three-degree landing approach under various shear conditions with and without specific information on the shear. Improved performance due to augmented cockpit information was observed. Critical shears with increasing tailwinds could be handled more consistently and with less deviation from the glide path.  
V.P.

**A79-20264 \*** HCN - A plausible source of purines, pyrimidines and amino acids on the primitive earth. J.-P. Ferris, P. C. Joshi, E. H. Edelson (Rensselaer Polytechnic Institute, Troy, N.Y.), and J. G. Lawless (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Molecular Evolution*, vol. 11, Oct. 6, 1978, p. 293-311. 59 refs. NSF Grants No. CHE-76-11000; No. MPS-73-04352; Grant No. NGR-30-018-148.

Dilute (0.1 M) solutions of HCN condense to oligomers at pH 9.2, and hydrolysis of these oligomers yields 4,5-dihydroxypyrimidine, orotic acid, 5-hydroxyuracil, adenine, 4-aminoimidazole-5-carboxamide, and amino acids. It is suggested that the three main classes of nitrogen-containing biomolecules - purines, pyrimidines, and amino acids - may have originated from HCN on the primitive earth. It is also suggested that the presence of orotic acid and 4-aminoimidazole-5-carboxamide might indicate that contemporary biosynthetic pathways for nucleotides evolved from the compounds released on hydrolysis of HCN oligomers. M.L.

**A79-21260 \* //** Developing closed life support systems for large space habitats. J. M. Phillips, A. D. Harlan, and K. C. Krumhar (Arizona, University, Tucson, Ariz.). *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 1-3 Nov. 2, 1978, Paper 78-145*. 34 p. 59 refs. Grant No. NSG-2309.

In anticipation of possible large-scale, long-duration space missions which may be conducted in the future, NASA has begun to investigate the research and technology development requirements to create life support systems for large space habitats. An analysis suggests the feasibility of a regeneration of food in missions which exceed four years duration. Regeneration of food in space may be justified for missions of shorter duration when large crews must be supported at remote sites such as lunar bases and space manufacturing facilities. It is thought that biological components consisting principally of traditional crop and livestock species will prove to be the most acceptable means of closing the food cycle. A description is presented of the preliminary results of a study of potential biological components for large space habitats. Attention is given to controlled ecosystems, Russian life support system research, controlled-environment agriculture, and the social aspects of the life-support system. G.R.

**A79-22083 \*** The Viking biological investigations - Review and status. H. P. Klein (NASA, Ames Research Center, Moffett Field, Calif.). *Origins of Life*, vol. 9, Dec. 1978, p. 157-160. 27 refs.

The three experimental approaches incorporated into the Viking biology instrument have yielded results that are most readily explained as nonbiological phenomena. The predominant view among investigators trying to simulate the Mars results is that the surface material of Mars contains strongly oxidizing compounds which would account for many of the more intense reactions seen on Mars. Other mechanisms are also currently being proposed and studied.

(Author)

**A79-23470 \*** Cardiovascular regulatory response to lower body negative pressure following blood volume loss. M. Shimizu, D. N. Ghista, and H. Sandler (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Aviation, Space, and Environmental Medicine*, vol. 50, Jan. 1979, p. 24-33. 26 refs.

An attempt is made to explain the cardiovascular regulatory responses to lower body negative pressure (LBNP) stress, both in the absence of and following blood or plasma volume loss, the latter being factors regularly observed with short- or long-term recumbency or weightlessness and associated with resulting cardiovascular deconditioning. Analytical expressions are derived for the responses of mean venous pressure and blood volume pooled in the lower body due to LBNP. An analysis is presented for determining the HR change due to LBNP stress following blood volume loss. It is concluded that the reduced orthostatic tolerance following long-term

space flight or recumbency can be mainly attributed to blood volume loss; and that the associated cardiovascular responses characterizing this orthostatic intolerance is elicited by the associated central venous pressure response. S.D.

**A79-24175 \*** Venus lower atmospheric composition - Analysis by gas chromatography. V. I. Oyama, G. C. Carle, F. Woeller, and J. B. Pollack (NASA, Ames Research Center, Moffett Field, Calif.). *Science*, vol. 203, Feb. 23, 1979, p. 802-805. 22 refs.

The first gas chromatographic analysis of the lower atmosphere of Venus is reported. Three atmospheric samples were analyzed. The third of these samples showed carbon dioxide (96.4 percent), molecular nitrogen (3.41 percent), water vapor (0.135 percent), molecular oxygen (69.3 ppm), argon (18.6 ppm), neon (4.31 ppm), and sulfur dioxide (186 ppm). The amounts of water vapor and sulfur dioxide detected are roughly compatible with the requirements of greenhouse models of the high surface temperature of Venus. The large positive gradient of sulfur dioxide, molecular oxygen, and water vapor from the cloud tops to their bottoms, as implied by Earth-based observations and these results, gives added support for the presence of major quantities of aqueous sulfuric acid in the clouds. A comparison of the inventory of inert gases found in the atmospheres of Venus, Earth, and Mars suggests that these components are due to outgassing from the planetary interiors.

(Author)

**A79-24879 \* //** Some perspectives on research into the biological response to non-ionizing electromagnetic radiation. J. C. Sharp (NASA, Ames Research Center, Moffett Field, Calif.). *Radio Science*, vol. 14, Jan.-Feb. 1979, p. 5-10.

Research on the biological effects of RF radiation in the United States has undergone a series of swings during the last three decades. The resurgence of research during the past decade is examined in the light of two projects: the proposed Space Power Station and SETI.

B.J.

**A79-26370 \*** Configurations of base-pair complexes in solutions. J. T. Egan (NASA, Ames Research Center, Moffett Field, Calif., New York, State University, Buffalo, N.Y.), S. Nir, R. Rein (Roswell Park Memorial Institute, Buffalo, N.Y.), and R. MacElroy (NASA, Ames Research Center, Moffett Field, Calif.). *International Journal of Quantum Chemistry, Quantum Biology Symposium* no. 5, 1978, p. 433-440. 40 refs. Grants No. NCA2-OR635-701; No. NSG 7305; No. NIH-GM-23850-01.

A theoretical search for the most stable conformations (i.e., stacked or hydrogen bonded) of the base pairs A-U and G-C in water,  $\text{CCl}_4$ , and  $\text{CHCl}_3$  solutions is presented. The calculations of free energies indicate a significant role of the solvent in determining the conformations of the base-pair complexes. The application of the continuum method yields preferred conformations in good agreement with experiment. Results of the calculations with this method emphasize the importance of both the electrostatic interactions between the two bases in a complex, and the dipolar interaction of the complex with the entire medium. In calculations with the solvation shell method, the last term, i.e., dipolar interaction of the complex with the entire medium, was added. With this modification the prediction of the solvation shell model agrees both with the continuum model and with experiment, i.e., in water the stacked conformation of the bases is preferred.

(Author)

**A79-26371 \*** Optimum geometries and relative energies for guanine, the imino-enol tautomer of guanine, the enol tautomer of guanine, adenine, and the imino tautomer of adenine as found by the MINDO/2 SCF MO method. T. J. Zielinski (College of Mount Saint

Vincent on Hudson, Riverdale, N.Y.), D. L. Breen (Auburn University, Auburn, Ala.), K. Haydock, R. Rein (Roswell Park Memorial Institute; New York, State University, Buffalo, N.Y.), and R. D. MacElroy (NASA, Ames Research Center, Moffett Field, Calif.). *International Journal of Quantum Chemistry, Quantum Biology Symposium* no. 5, 1978, p. 355-365. 17 refs.

**A79-26436 \* # Elimination of chromite and novel sulfides as important carriers of noble gases in carbonaceous meteorites.** U. Frick (Minnesota, University, Minneapolis, Minn.) and S. Chang (NASA, Ames Research Center, Extraterrestrial Research Div., Moffett Field, Calif.). (*Meteoritical Society, Annual Meeting, 41st, Sudbury, Ontario, Canada, Aug. 14-17, 1978.*) *Meteoritics*, vol. 13, Dec. 31, 1978, p. 465-470. 14 refs. Abridged. Grants No. NGL-75-003; No. NGL-24-005-225.

**meteorite.** J. N. Goswami, D. Lal, M. N. Rao, N. Sinha, and T. R. Venkatesan (Physical Research Laboratory, Ahmedabad, India). (*Meteoritical Society, Annual Meeting, 41st, Sudbury, Ontario, Canada, Aug. 14-17, 1978.*) *Meteoritics*, vol. 13, Dec. 31, 1978, p. 481-484. 11 refs. Abridged.

**A79-26547 \* Selective photodestruction of alpha-amino acids.** N. Levi and J. G. Lawless (NASA, Ames Research Center, Moffett Field, Calif.). *Analytical Biochemistry*, vol. 90, 1978, p. 796-801. 14 refs.

A problem encountered in the analysis of amino acids in chemical evolution experiments and in extracts of meteorites is the large number present. A method for selectively destroying the alpha-amino acids, with only the beta- and gamma-amino acids remaining in the solution, is described. The amino acids used were racemic, with one milliliter of solution containing 0.0000025 mol of each acid irradiated in a 1-cm quartz cell having 254-nm monochromatic light in the presence of CuCl<sub>2</sub>. Excess H<sub>2</sub>S was added to precipitate the Cu (2+) as CuS. A gas chromatographic analysis was used to observe that irradiation with 254-nm light in the presence of Cu (2+) destroyed all the amino acids except the beta and the gamma types. It is concluded that with such a procedure, complex mixtures of amino acids can be simplified to make identification by GC mass spectrometry easier.

A.A.

**A79-26895 \* # The annoyance of multiple noisy events.** A. Ahumada, Jr. (Stanford University, Stanford, Calif.) and D. C. Nagel (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 5th, Seattle, Wash., Mar. 12-14, 1979, Paper 79-0653.* 7 p. 9 refs.

A total of 24 subjects (17 M, 7 F) was tested in an experimental study of annoyance rating of multiple noisy events (30 sets of noise bursts). The scaling technique known as functional measurement was used to determine whether annoyance integrates additively over events and if so, to measure the power law exponent which relates the levels of the events to the additive scale values. To this end, groups of three noises were presented at three levels in a factorial arrangement to check the additivity hypothesis and to estimate the scaling function. Also, a series of sets of noises of constant level but varying in set size were considered. The functional measurement of annoyance ratings of sets of three simulated flyovers showed that the integration of annoyance can be represented as an additive process in terms of scale values that are power functions of the sound power with a power-law exponent near 0.7.

S.D.

**A79-27226 \* Senescent changes in the ribosomes of animal cells in vivo and in vitro.** J. Miquel (NASA, Ames Research Center, Moffett Field, Calif.) and J. E. Johnson, Jr. (National Institutes of Health, National Institute on Aging, Baltimore City Hospital, Baltimore, Md.). *Mechanisms of Ageing and Development*, vol. 9, 1979, p. 247-266. 106 refs.

The paper examines RNA-ribosomal changes observed in protozoa and fixed postmitotic cells, as well as the characteristics of intermitotic cells. Attention is given to a discussion of the implications of the reported ribosomal changes as to the senescent deterioration of protein synthesis and physiological functions. A survey of the literature suggests that, while the data on ribosomal change in dividing cells both *in vivo* and *in vitro* are inconclusive, there is strong histological and biochemical evidence in favor of some degree of quantitative ribosomal loss in fixed postmitotic cells. Since these decreases in ribosomes are demonstrated in differential cells from nematodes, insects and mammals, they may represent a universal manifestation of cytoplasmic senescence in certain types of fixed postmitotic animal cells. The observed variability in ribosomal loss for cells belonging to the same type suggests that this involution phenomenon is rather related to the wear and tear suffered by a particular cell.

S.D.

**A79-27553 \* RBC-Cr-51/ half-life and albumin turnover in growing Beagle dogs during chronic radial acceleration.** D. A. Beckman, J. W. Evans (California, University, Davis, Calif.), and J. Oyama (NASA, Ames Research Center, Biomedical Research Div., Moffett Field; California, University, Davis, Calif.). *Aviation, Space, and Environmental Medicine*, vol. 50, Mar. 1979, p. 212-217. 30 refs. Grant No. NCA2-OR180-505.

The effects of chronic centrifugation on growing Beagle dogs exposed to -2 or -2.6 Gx on albumin and RBC turnover rates, albumin concentration and space, and total blood volume were determined and compared with caged and run control of animals. Albumin-(I-125) and autologous RBC-(Cr-51) preparations were injected into all dogs at day 82 of the centrifugation periods, and the disappearance curves were determined by successive bleedings of the animals over the next 35 d, during which the centrifugation was continued. There were no differences in albumin turnover rates or space. Two populations of RBCs were found in both centrifuged groups, one with a normal half-life of 27 + or - 1 S.E.M. d, and one with a significantly (p less than 0.01) shorter half-life of 15 + or - 2 S.E.M. d. An absolute polycythemia was also observed in both centrifuged groups. The results suggest that chronic centrifugation acts through some as-yet unknown mechanism to affect RBC population kinetics.

(Author)

**A79-27928 \* The response of selected terrestrial organisms to the Martian environment - A modeling study.** W. R. Kuhn (Michigan, University, Ann Arbor, Mich.), S. R. Rogers (Sloan-Kettering Institute for Cancer Research, New York, N.Y.), and R. D. MacElroy (NASA, Ames Research Center, Extraterrestrial Research Div., Moffett Field, Calif.). *Icarus*, vol. 37, Jan. 1979, p. 336-346. 22 refs. NASA Order A-17362-B.

An energy balance model has been developed to investigate how the Martian atmospheric environment could influence a community of photosynthetic microorganisms with properties similar to those of a cyanophyte (blue-green algal mat) and a lichen. Surface moisture and soil nutrients are assumed to be available. The model was developed to approximate equatorial equinox conditions and includes parameters for solar and thermal radiation, convective and conductive energy transport, and evaporative cooling. Calculations include the diurnal variation of organism temperature and transpiration and photosynthetic rates. The influences of different wind speeds and organism size and resistivity are also studied. The temperature of organisms in mats less than a few millimeters thick will not differ from the ground temperature by more than 10 K. Water loss is actually retarded at higher wind speeds, since the organism temperature is lowered, thus reducing the saturation vapor pressure. Typical photosynthetic rates lead to the production of 1 millionth to 100 billionths mola O<sub>2</sub> per sq cm/day.

(Author)

**A79-29336 \* Plasma volume and electrolyte shifts with heavy exercise in sitting and supine positions.** J. E. Greenleaf, W. Van Beaumont, P. J. Brock, J. T. Morse, and G. R. Mangseth (NASA,

Ames Research Center, Laboratory of Human Environmental Physiology, Moffett Field, Calif.). *American Journal of Physiology*, vol. 236, Mar. 1979, p. R206-R214. 24 refs.

An experimental study was carried out to compare fluid and electrolyte shifts after heavy exercise performed by four voluntary male subjects (26-45 yr) in sitting and supine positions. Plasma volume and electrolyte shifts were measured during the 6-min control period and for 60 min after a continuous peak oxygen uptake test. The results indicate that the most likely driving force for the restitution of plasma volume after peak exercise is provided by a change in hydrostatic and/or systemic blood pressures when exercise ceases.

S.D.

**A79-29925 \*** Effect of electroconvulsive shock on monoaminergic receptor binding sites in rat brain. D. A. Bergstrom and K. J. Kellar (Georgetown University, Washington, D.C.). *Nature*, vol. 278, Mar. 29, 1979, p. 464-466. 30 refs. Grants No. PHS-12566; No. NCA2-OR258-701.

**A79-29938 \*** Prebiotic nucleotide oligomerization in a fluctuating environment - Effects of kaolinite and cyanamide. D. G. Odom, N. Lahav, and S. Chang (NASA, Ames Research Center, Extraterrestrial Research Div., Moffett Field, Calif.). *Journal of Molecular Evolution*, vol. 12, Mar. 15, 1979, p. 259-264. 15 refs.

The clay kaolinite was tested for its ability to promote nucleotide oligomerization in model prebiotic systems. Heterogeneous mixtures of clay, water and nucleotide were repeatedly evaporated to dryness at 60°C and redissolved in water in cyclic fashion in the presence or absence of cyanamide and/or ammonium chloride. With or without cycling, kaolinite alone did not promote the oligomerization of nucleotides at detectable levels. Cycling of clay in combination with cyanamide, however, promoted high levels of condensation to a mixture of oligonucleotides and dinucleotide pyrophosphate without requiring ammonium chloride. Although cycling with clay favored synthesis of dinucleotide pyrophosphate, cycling without clay enhanced formation of oligonucleotides. These results support the hypothesis that the presence of clays in fluctuating environments would have influenced the course of prebiotic condensation reactions.

(Author)

**A79-30125 \*** Effects of aeration on formation and localization of the acetyl coenzyme A synthetases of *Saccharomyces cerevisiae*. H. P. Klein and L. Jahnke (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Bacteriology*, vol. 137, Jan. 1979, p. 179-184. 20 refs.

Previous studies on the yeast *Saccharomyces cerevisiae* have shown that two different forms of the enzyme acetyl coenzyme A synthetase (ACS) are present, depending on the conditions under which the cells are grown. The paper evaluates the usefulness of a method designed to assay both synthetases simultaneously in yeast homogenates. The data presented confirm the possibility of simultaneous detection and estimation of the amount of both ACSs of *S. cerevisiae* in crude homogenates of this strain, making possible the study of physiological factors involved in the formation of these isoenzymes. One important factor for specifying which of the two enzymes is found in these yeast cells is the presence or absence of oxygen in their environment. Aeration not only affects the ratio of the two ACSs but also appears to affect the cellular distribution of these enzymes. Most of the data presented suggest the possibility that the nonaerobic ACS may serve as a precursor to the aerobic form.

S.D.

**A79-30624 \*** Effect of sodium and calcium ingestion on thermoregulation during exercise in man. J. E. Greenleaf, P. J. Brock, J. T. Morse, W. Van Beaumont, L. D. Montgomery, V. A. Convertino, and G. R. Mangseth (NASA, Ames Research Center, Moffett Field, Calif.). In: *New trends in thermal physiology*. Paris, Masson, 1978, p. 157-160. 5 refs.

The effects of hypertonic sodium and calcium ingestion on body temperature during exercise in cool and hot environments are investigated. Rectal and mean skin temperatures, sweat rates and arm

and leg total blood flows were measured in men during periods of rest, submaximal exercise and recovery at temperatures of 26.5°C and 39.4°C after ingestion of NaCl and CaCl<sub>2</sub> solutions. In both environments, higher rectal temperatures are observed after hypertonic sodium ingestion, which is also associated with attenuated blood flow in the extremities, lower sweat rates and slightly higher skin temperature in the heat, indicating significant thermoregulatory responses. Hypertonic calcium and isotonic sodium cause no temperature change, although calcium caused a reduction of blood flow in the extremities.

A.L.W.

**A79-31337 \*** COS in the stratosphere. E. C. Y. Inn, J. F. Vedder, B. J. Tyson (NASA, Ames Research Center, Moffett Field, Calif.), and D. O'Hara (LFE Corp., Richmond, Calif.). *Geophysical Research Letters*, vol. 6, Mar. 1979, p. 191-193. 9 refs.

Carbonyl sulfide (COS) has been detected in the stratosphere, and mixing ratio measurements are reported for altitudes of 15.2 to 31.2 km. A large volume, cryogenic sampling system mounted on board a U-2 aircraft has been used for lower stratosphere measurements and a balloon platform for measurement at 31.2 km. These observations and measurements strongly support the concept that stratospheric COS is an important precursor in the formation of sulfuric acid aerosols.

(Author)

**A79-31981 \*** Apparent cooperativity of amino acid transport in *Halobacterium halobium* - Effect of electrical potential. J. K. Lanyi (NASA, Ames Research Center, Extraterrestrial Biology Div., Moffett Field, Calif.). *Archives of Biochemistry and Biophysics*, vol. 191, Dec. 1978, p. 821-824. 18 refs.

Active serine accumulation in cell envelope vesicles from *Halobacterium halobium* proceeds by co-transport with Na<sup>+</sup> and can be induced by either transmembrane electrical potential or transmembrane Na<sup>+</sup> concentration difference. It was shown earlier that in the former case the initial transport rate is a fourth-power function of the magnitude of the electrochemical potential difference of sodium ions, and in the latter, a second-power function. A possible interpretation of this finding is cooperativity of sodium-transporting sites in the transport carrier. When both kinds of driving force are imposed simultaneously on the vesicles, fourth-power dependence on the total potential difference of sodium ions is obtained, suggesting that the transport carrier is regulated by the electrical potential. Heat treatment of the vesicles at 48°C partially inactivates transport and abolishes this effect of the electrical potential.

(Author)

**A79-32252 \*** An optimized potential function for the calculation of nucleic acid interaction energies. I - Base stacking. R. L. Ornstein (Roswell Park Memorial Institute, Buffalo, N.Y.), R. Rein (New York, State University, Buffalo, N.Y.), D. L. Breen (Auburn University, Auburn, Ala.), and R. D. MacElroy (NASA, Ames Research Center, Moffett Field, Calif.). *Biopolymers*, vol. 17, Oct. 1978, p. 2341-2360. 32 refs. Grants No. NCA2-OR635-701; No. NsG-3705; No. PHS-CA-17609.

**A79-32920 #** Kinetics of spreading and contact interaction in systems with the formation of intermediate phases (Kinetika roztikannia i kontaktna vzaemodzia v sistemakh z utvoreniami promizhnikh faz). V. N. Eremenko, N. D. Lesnik, and T. S. Ivanova. *Akademii Nauk Ukrains'koi RSR. Visnik*, vol. 43, Feb. 1979, p. 7-18. 44 refs. In Ukrainian.

The basic theory of the spreading of liquids on solid surfaces is discussed with reference to the formation of intermediate phases and it is applied to the spreading of liquid metals on solid metallic surfaces. Particular consideration is given to data on the kinetics of spreading for the systems Sn-Mo, In-CO, Al-CO, and Al-Ni. Detailed attention is then paid to the spreading of liquid iron (and of metals

of the iron family) on aluminum and its alloy and to the spreading of liquid aluminum on iron (and metals of the iron family). B.J.

**A79-32925 \*** Association of nucleotides with homoionic clays. D. G. Odom (Cornell College, Mount Vernon, Iowa), M. Rao, J. Oro (Houston, University, Houston, Tex.), and J. G. Lawless (NASA, Ames Research Center, Exobiology Div., Moffett Field, Calif.). *Journal of Molecular Evolution*, vol. 12, Apr. 12, 1979, p. 365-367. 7 refs.

The binding of nucleotides to homoionic clays is studied as a possible mechanism for the concentration and catalysis of biological or prebiotic materials on the prebiotic earth. Samples of radioactively labeled adenosine and thymidine nucleotides were mixed in solutions with bentonite, kaolinite or Dowex-50 particles in which all exchangeable sites were occupied by Na, Mg, Ca, Mn, Fe, Cu or Zn ions. The binding of nucleotides to homoionic clays is observed, with adenosine nucleotides favored over thymidine, bentonite as the best absorber, and greater binding to clays homoionic in transition metal ions. Results indicate that the oligomerization of nucleotides may be possible by this mechanism, however difficulties in nucleotide variability and base pairing may arise due to the observed preference for purines at the adsorption sites. A.L.W.

**A79-33049 \*** Spaceflight and bone turnover - Correlation with a new rat model of weightlessness. E. R. Morey (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Bioscience*, vol. 29, Mar. 1979, p. 168-172. 14 refs.

Earlier manned spaceflight studies have revealed that the near-weightless environment of orbital flight produce certain biological effects in humans, including abnormalities in mineral metabolism. The data collected were compatible with bone mineral loss. Cosmos 782 and 936 experiments have shown a decrease in rat bone formation rate. In this paper, a rat model of weightlessness is described, which is unique in that the animal is free to move about a 360-deg arc. The model meets the requirements for an acceptable system. Data from the model and spaceflight are presented. Many of the responses noted in suspended animals indicate that the model closely mimics results from rats and man exposed to near-weightlessness during orbital spaceflight. S.D.

**A79-33050 \*** The joint US-USSR biological satellite program. K. A. Souza (NASA, Ames Research Center, Biosystems Div., Moffett Field, Calif.). *BioScience*, vol. 29, Mar. 1979, p. 160-167. 30 refs.

The joint US-USSR biological satellite missions carried out in 1975 and 1977 using Cosmos 782 and Cosmos 936 spacecraft, respectively, is reviewed. The experimental equipment and the biological specimens aboard the aircraft are considered, and it is noted that Cosmos 782, unlike Cosmos 936, carried no centrifuges for rats, although it did contain a centrifuge where a variety of biological specimens, including carrot tissue and fruit flies, were subjected to artificial gravity during space flight. The ground control groups, designed for biological experiments under simulated space-conditions, are taken into account. The U.S. experiments aboard the aircraft are described, with attention given to the experiments with rats, fish embryos, plants, and insects. Results of the experiments are noted, including the finding that space flight factors, especially weightlessness, have a measurable effect on the erythropoietic and musculoskeletal systems of rats. A.A.

**A79-33803 \*** Sweating responses during heat acclimation and moderate conditioning. E. Shvartz, A. Bhattacharya, S. J. Sperinde, P. J. Brock, D. Sciarra, and W. Van Beaumont (NASA, Ames Research Center, Biomedical Div., Moffett Field, Calif.). *Journal of Applied Physiology: Respiratory, Environmental and*

*Exercise Physiology*, vol. 46, Apr. 1979, p. 675-680. 18 refs.

Experiments were conducted on ten young male subjects to determine sweating onset, distribution, and patterns as well as the relationships of these responses to body temperature during heat acclimation and moderate conditioning performed in temperate (24 C) conditions. The subjects are randomly assigned to two groups of five subjects each. The experimental period consisted of eight successive days of either graded exercise to exhaustion on a bicycle ergometer in heat (acclimation group) or in a temperate environment (control group). Major conclusions are that (1) acclimation and conditioning result in relatively more sweat rate on the limbs than on the torso, but that these changes are less related to body temperature than torso sweat rate; and (2) sweating sensitivity increases during acclimation and conditioning, but its contribution to heat acclimation is minor. S.D.

**A79-34741 \*** Thermostructural design of a carbon-carbon heatshield for a Jovian entry. M. J. White, C. N. Heightland, and R. B. Dirlings, Jr. (Science Applications, Inc., Irvine, Calif.). In: Conference on Advanced Technology for Future Space Systems, Hampton, Va., May 8-10, 1979, Technical Papers. (A79-34701 14-12) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 333-342. 14 refs. Contract No. NAS2-9363. (AIAA 79-0920)

The thermostructural response of three candidate carbon-carbon composites for the Jovian entry probe heatshield was investigated. The analysis for the three materials, Sandia Felt, Carbitex 700, and SAI 4-D weave carbon-carbon was conducted using a dual finite element approach which involved heat conduction as well as the structural response. A receding boundary due to ablation and inertial loads encountered by the probe were included. Severe cracking, circumferential and radial, and interlaminar shear failure was observed during the radiative heating pulse for the Sandia Felt and Carbitex 700 materials, respectively. The 4-D weave material showed no failures over the entire entry. (Author)

**A79-37711 \*** Motion sickness in cats - A symptom rating scale used in laboratory and flight tests. K. B. Suri, N. G. Daunton (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.), G. H. Crampton (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.), Wright State University, Dayton, Ohio). *Aviation, Space, and Environmental Medicine*, vol. 50, June 1979, p. 614-618. 24 refs.

The cat is proposed as a model for the study of motion and space sickness. Development of a scale for rating the motion sickness severity in the cat is described. The scale is used to evaluate an antimotion sickness drug, d-amphetamine plus scopolamine, and to determine whether it is possible to predict sickness susceptibility during parabolic flight, including zero-G maneuvers, from scores obtained during ground based trials. (Author)

**A79-37932 \*** Prebiotic condensation reactions using cyanamide. E. Sherwood, D. W. Nooner, J. Eichberg, D. E. Epps, and J. Oro (Houston, University, Houston, Tex.). In: Origin of life; Proceedings of the Second ISSOL Meeting and Fifth ICOL Meeting, Kyoto, Japan, April 5-10, 1977. (A79-37919 15-55) Tokyo, Center for Academic Publications Japan, 1978, p. 105-111. 28 refs. Grants No. NIH-NS-12493; No. NGR-44-005-002; No. NCA2-OP295-0591.

Condensation reactions in cyanamide, 4-amino-5-imidazole-carboxamide and cyanamide, imidazole systems under dehydrating conditions at moderate temperatures (60 to 100 deg C) were investigated. The cyanamide, imidazole system was used for synthesis of palmitoylglycerols from ammonium palmitate and glycerol. With the addition of deoxythymidine to the former system, P1, P2-dideoxythymidine 5 prime-phosphate was obtained; the same cyanamide, 4-amino-5-imidazole-carboxamide system was used to synthesize deoxythymidine oligonucleotides using deoxythymidine 5

prime-phosphate and deoxythymidine 5 prime-triphosphate, and peptides using glycine, phenylalanine or isoleucine with adenosine 5 prime-triphosphate. The pH requirements for these reactions make their prebiotic significance questionable; however, it is conceivable that they could occur in stable pockets of low interlayer acidity in a clay such as montmorillonite.

C.K.D.

**A79-37939 \*** **Chemical evolution. XXIX - Pyrimidines from hydrogen cyanide.** J. P. Ferris, P. C. Joshi (Rensselaer Polytechnic Institute, Troy, N.Y.), and J. G. Lawless (NASA, Ames Research Center, Moffett Field, Calif.). In: *Origin of life; Proceedings of the Second ISSOL Meeting and Fifth ICOL Meeting*, Kyoto, Japan, April 5-10, 1977. (A79-37919 15-55) Tokyo, Center for Academic Publications Japan, 1978, p. 187-191. 28 refs. Grant No. NGR-30-018-148.

Compounds obtained by hydrolysis of HCN oligomers formed by allowing pH 9.2, 0.1 M cyanide to stand at room temperature for 4 to 12 months were analyzed. Hydrolysis of HCN oligomers yielded 4,5-dihydroxypyrimidine and 5-hydroxyuracil; orotic acid was detected after hydrolysis at pH 8.5. A unified pathway from diaminofumaronitrile to the pyrimidines observed is suggested. As purines, pyrimidines and amino acids are released by hydrolysis of HCN oligomers in either acidic or mildly basic aqueous solutions, they could have been formed on the primitive earth in spite of fluctuations in pH. 4,5-dihydroxypyrimidines appear to be likely candidates for incorporation into primitive nucleic acids, as they should undergo Watson-Crick hydrogen bonding with adenine.

C.K.D.

**A79-37950 \*** **A model for stereospecific recognition of purines as an element of a DNA polypeptide recognition code.** R. Rein, R. Garduno, J. T. Egan, S. Colombano (Roswell Park Memorial Institute, Buffalo, N.Y.), Y. Coeckelenbergh, and R. D. MacElroy (NASA, Ames Research Center, Moffett Field, Calif.). In: *Origin of life; Proceedings of the Second ISSOL Meeting and Fifth ICOL Meeting*, Kyoto, Japan, April 5-10, 1977. (A79-37919 15-55) Tokyo, Center for Academic Publications Japan, 1978, p. 265-272. 24 refs. Grants No. NCA2-OR635-601; No. NCA2-635-701; No. NSG-3705; No. PHS-CA-17609.

**A79-39236 \*** **Carbon, nitrogen and sulfur Apollo 15, 16 and 17 rocks.** D. J. Des Marais (NASA, Ames Research Center, Moffett Field, Calif.). In: *Lunar and Planetary Science Conference, 9th*, Houston, Tex., March 13-17, 1978, Proceedings. Volume 2. (A79-39176 16-91) New York, Pergamon Press, Inc., 1978, p. 2451-2467. 60 refs. NASA-supported research.

Carbon, nitrogen and sulfur contents, as well as carbon isotopic compositions, were determined for seven lunar rocks from the Apollo 15, 16 and 17 missions. Sequential combustion at three temperatures was used to resolve terrestrial contamination from indigenous lunar volatiles. Nitrogen abundances averaged 0.4 micrograms/gram in the samples. The results of the sequential combustion analysis suggested that all the samples contained variable amounts of terrestrial carbon contamination prior to examination. Indigenous lunar carbon abundances ranging from 2.5 to 6 micrograms/gram were found. Thus the moon appears to be substantially depleted in nitrogen and carbon relative to the earth and C and H meteorites.

J.M.B.

**A79-37948 \*** **An approach to the origin of self-replicating system. I - Intermolecular interactions.** R. D. MacElroy, Y. Coeckelenbergh (NASA, Ames Research Center, Extraterrestrial Biology Div., Moffett Field, Calif.) and R. Rein (Roswell Park Memorial Institute, Buffalo, N.Y.). In: *Origin of life; Proceedings of the Second ISSOL Meeting and Fifth ICOL Meeting*, Kyoto, Japan, April 5-10, 1977. (A79-37919 15-55) Tokyo, Center for Academic Publications Japan, 1978, p. 249-254. 33 refs.

The present paper deals with the characteristics and potentialities of a recently developed computer-based molecular modeling system. Some characteristics of current coding systems are examined and are extrapolated to the apparent requirements of primitive prebiological coding systems.

V.P.

**A79-39970 \*** **Automated electrical impedance technique for rapid enumeration of fecal coliforms in effluents from sewage treatment plants.** M. P. Silverman and E. F. Munoz (NASA, Ames Research Center, Extraterrestrial Research Div., Moffett Field, Calif.). *Applied and Environmental Microbiology*, vol. 37, Mar. 1979, p. F21-526. 21 refs.

**A79-39971 \*** **Rapid, single-step most-probable-number method for enumerating fecal coliforms in effluents from sewage treatment plants.** E. F. Munoz and M. P. Silverman (NASA, Ames Research Center, Extraterrestrial Research Div., Moffett Field, Calif.). *Applied and Environmental Microbiology*, vol. 37, Mar. 1979, p. 527-530. 13 refs.

A single-step most-probable-number method for determining the number of fecal coliform bacteria present in sewage treatment plant effluents is discussed. A single growth medium based on that of Reasoner et al. (1976) and consisting of 5.0 gr. proteose peptone, 3.0 gr. yeast extract, 10.0 gr. lactose, 7.5 gr. NaCl, 0.2 gr. sodium lauryl sulfate, and 0.1 gr. sodium desoxycholate per liter is used. The pH is adjusted to 6.5, and samples are incubated at 44.5 deg C. Bacterial growth is detected either by measuring the increase with time in the electrical impedance ratio between the inoculated sample vial and an uninoculated reference vial or by visual examination for turbidity. Results obtained by the single-step method for chlorinated and unchlorinated effluent samples are in excellent agreement with those obtained by the standard method. It is suggested that in automated treatment plants impedance ratio data could be automatically matched by computer programs with the appropriate dilution factors and most probable number tables already in the computer memory, with the corresponding result displayed as fecal coliforms per 100 ml of effluent.

C.K.D.

**A79-40271 \*** **Plasma polymerization of ethylene in an atmospheric pressure-pulsed discharge.** K. Donohoe and T. Wydeven (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Applied Polymer Science*, vol. 23, 1979, p. 2591-2601. 17 refs.

The polymerization of ethylene in an atmospheric pressure-pulsed discharge has been studied. Partial pressures of ethylene up to 4 kN/sq m were used with helium as a diluent. Deposition rates (on glass slides) were the same throughout the discharge volume over a wide range of operating conditions. These rates were in the 1-2 Å/sec range. The films were clear, soft, and showed good adhesion to the glass substrates. Oligomers large enough to visibly scatter 637.8-nm light were observed in the gas phase under all conditions in which film deposition occurred. The experimental results suggest that Brownian diffusion of these oligomers was the rate-limiting step in the film deposition process. (Author)

**A79-40672 \*** Low tryptophan diet decreases brain serotonin and alters response to apomorphine. B. J. Sahakian (MIT, Cambridge; Massachusetts, University, Worcester, Mass.), R. J. Wurtman, J. K. Barr, W. R. Millington, and H. J. Chiel (MIT, Cambridge, Mass.). *Nature*, vol. 279, June 21, 1979, p. 731, 732. 24 refs. Grants No. NIH-AM-14228; No. NGR-22-009-627.

The role of the serotonergic system in the regulation of apomorphine-induced behavior, a behavior primarily controlled by dopaminergic neurotransmission, was investigated in rats fed on a low tryptophan diet since weaning. It was found that reductions in brain serotonin (5-HT) produced by diet result in decreased stereotypy after apomorphine administration. This indicates that although stereotyped behavior is primarily mediated by dopaminergic mechanisms, it can also be modulated by other neurotransmitter including 5-HT. It was also shown that changes in brain serotonin levels can affect psychomotor stimulant-induced hypothermia. C.K.D.

**A79-40775 \*** Relationship between proton motive force and potassium ion transport in *Halobacterium halobium* envelope vesicles. J. K. Lanyi, S. L. Helgerson, and M. P. Silverman (NASA, Ames Research Center, Extraterrestrial Biology Div., Moffett Field, Calif.). *Archives of Biochemistry and Biophysics*, vol. 193, Apr. 1, 1979, p. 329-339. 31 refs.

The permeability of *Halobacterium halobium* vesicle membranes to potassium ions was investigated, and possible mechanisms for the regulation of the gradient of protons by the transmembrane movement of these ions were studied. The lack of a potassium ion diffusion potential in the absence of valinomycin, light-induced electrical potentials in excess of the chemical potential difference for potassium ions, and direct measurements of potassium ion influx during illumination show that the membranes are relatively impermeable to these ions. As a result of sodium ion extrusion during illumination, chlorine ions and water must be lost and the vesicles collapse. The light-induced collapse of vesicles is diminished only if the influx of potassium ions is increased. C.K.D.

**A79-40812 \*** Laboratory corroboration of the Pioneer Venus gas chromatograph analyses. V. I. Oyama, G. C. Carle, F. Woeller, and J. B. Pollack (NASA, Ames Research Center, Moffett Field, Calif.). *Science*, vol. 205, July 6, 1979, p. 52-54. 11 refs.

Laboratory simulation and tests of the inlet sampling system and columns of the Pioneer Venus gas chromatograph show that the sensitivity to argon is not diminished after the column regeneration step, that argon isotopes are not separated, that oxygen and sulfur dioxide are not produced in the inlet sampling system from sulfur trioxide, and that sulfur trioxide is not formed from sulfur dioxide and oxygen. Comparisons of the volatile inventory of Venus and earth imply similar efficiencies of early outgassing but a lower efficiency for later outgassing in the case of Venus. The high oxidation state of the Venus atmosphere in the region of cloud formation may prohibit the generation of elemental sulfur particles. (Author)

**A79-41185 \*** Thermoregulation in unrestrained rats during and after exposure to 1.5-4 G. J. Giacchino, B. A. Horwitz, and J. M. Horowitz (California, University, Davis, Calif.). *Journal of Applied Physiology: Respiratory, Environmental and Exercise Physiology*, vol. 46, June 1979, p. 1049-1053. 11 refs. Grant No. NSG-2234.

Unrestrained rats were exposed to cold for 1 h during and immediately after exposure to hypergravic fields (1.5-4 G) to determine if they recover their ability to thermoregulate on reentry to 1-G conditions. In contrast to the decreased body temperatures observed when cold exposure occurred concurrently with acceleration, hypothalamic, carotid, and brown fat temperatures did not fall when rats were exposed to cold immediately after return to 1 G. These results support the hypothesis that the thermoregulatory alterations seen under hypergravic conditions are manifestations of an effect of ongoing exposure to hypergravity and can be reversed on termination of acceleration. The reversibility of the thermoregulatory impairment is apparently unaffected by the magnitude of the acceleration field over a range of 1.5-4 G. (Author)

**A79-41704 \*** Serendipitous solution to the problem of culturing *Arabidopsis* plants in sealed containers for spaceflights of long duration. A. H. Brown, P. O'Dowd, L. Loercher, R. Kuniewicz and A. O. Dahl (Pennsylvania, University, Philadelphia, Pa.). In: *Life sciences and space research XVII: Proceedings of the Open Meeting of the Working Group on Space Biology, May 29-June 10, 1978, and Symposium on Gravitational Physiology, Innsbruck, Austria, June 2, 3, 1978*. (A79-41701 17-51) Oxford, Pergamon Press, Ltd., 1979, p. 37-43. 13 refs. Contract No. NAS2-2432.

The *Arabidopsis thaliana* plant species is tested to determine how a higher plant will develop from seed to maturity when deprived of all gravitational information that it might use to control its growth. Experimental results show that *Arabidopsis* seedlings can develop to maturity by means of a light-dependent but CO<sub>2</sub>-independent metabolism that feeds on organic compounds derived from the culture medium. This process is identified as photoassimilation. The ability of a higher plant to nourish itself by photoassimilation and thereby to survive in a hermetically sealed chamber of small dimensions is more than a biochemical curiosity. It allows the botanical investigator to design a culture system convenient for space-flight applications, which ensures isolation of each test plant from the gaseous environment of the spacecraft. S.D.

**A79-41713 \*** Continuous metabolic and cardiovascular measurements on a monkey subject during a simulated 6-day Spacelab mission. N. Pace, D. F. Rahmann, R. C. Mains, A. M. Kodama (California, University, Berkeley, Calif.), and E. P. McCutcheon (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). In: *Life sciences and space research XVII: Proceedings of the Open Meeting of the Working Group on Space Biology, May 29-June 10, 1978, and Symposium on Gravitational Physiology, Innsbruck, Austria, June 2, 3, 1978*. (A79-41701 17-51) Oxford, Pergamon Press, Ltd., 1979, p. 193-198. 6 refs. Grant No. NSG-7262.

A 10-kg male pig-tailed monkey (*Macaca nemestrina*) was selected as an optimal species for spaceflight studies on weightlessness. Three days before the simulated launch, the animal was placed in a fiberglass pod system to provide continuous measurement of respiratory gas exchange. Attention is given to examining the effects of weightlessness on several basic parameters of metabolic and cardiovascular function in an adult nonhuman primate. The 10.7-day total simulated-experiment period consisted of preflight 2.6 days, inflight 6.3 days, and postflight 1.8 days. Statistically significant diurnal variation was noted in oxygen consumption and CO<sub>2</sub> production rates, body temperature and HR, but not in respiratory quotient or blood pressure. The high quality of the continuous data obtained demonstrates the feasibility of performing sound physiological experimentation on nonhuman primates in the Spacelab environment. S.D.

**A79-43207 \*** Analysis of population mortality kinetics with application to the longevity followup of the Navy's '1,000 aviators'. A. C. Economos (Technology, Inc., Life Sciences Div., Mountain View, Calif.) and J. Miquel (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Aviation, Space, and Environmental Medicine*, vol. 50, July 1979, p. 697-701. 8 refs. Contract No. NAS2-10053.

A simple physiological model of mortality kinetics is used to assess the intuitive concept that the aging rates of populations are proportional to their mortality rates. It is assumed that the vitality of an individual can be expressed as a simple summation of the weighted functional capacities of its organs and homeostatic systems that are indispensable for survival. It is shown that the mortality kinetics of a population can be derived by a linear transformation of the frequency distribution of vitality, assuming a uniform constant rate of decline of the physiological functions. A simple comparison of two populations is not possible when they have different vitality frequency distributions. Analysis of the data using the model suggests that the differences in decline of survivorship with age between the military pilot population, a medically insured population, and the control population can be accounted for by the effect of physical selection on the vitality frequency distribution of the screened populations.

S.D.

**A79-43208 \*** Limb blood flow - Rest and heavy exercise in sitting and supine positions in man. J. E. Greenleaf, L. D. Montgomery (NASA, Ames Research Center, Laboratory of Human Environmental Physiology, Moffett Field, Calif.), P. J. Brock (NASA, Ames Research Center, Laboratory of Human Environmental Physiology, Moffett Field; California State University, Hayward, Calif.), and W. Van Beaumont (NASA, Ames Research Center, Laboratory of Human Environmental Physiology, Moffett Field, Calif.; St. Louis, University, St. Louis, Mo.). *Aviation, Space, and Environmental Medicine*, vol. 50, July 1979, p. 702-707. 31 refs.

The objectives of the study were twofold: (1) to determine the effect of body position (hydrostatic pressure) on total blood flow in active and passive limbs at rest and after severe exercise; and (2) to further evaluate the impedance technique for measurement of blood flow. To this end, the effect of body position on the redistribution of total blood flow in active (leg) and passive (forearm) limbs during exercise was determined by measuring total limb impedance (blood flow) in five male and one female subjects in sitting and supine positions with a modified Beckman BR-100 rheograph. The results show that at rest and after exercise, the supine position induces significantly greater flows in the leg but not in the forearm. With severe exercise, blood flows are increased in both passive and active limbs, so that there is probably no net transfer of blood volume from passive to active muscles. The advantages of the impedance technique over other methods are stressed.

S.D.

**A79-43605 \*** Inhibition of the pituitary-adrenal response to stress during deprivation-induced feeding. J. P. Heybach and J. Vernikos-Danellis (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Endocrinology*, vol. 104, no. 4, 1979, p. 967-973. 14 refs.

Plasma corticosterone and plasma and pituitary ACTH concentrations were determined during feeding and after application of an acute stress at various times after food and water presentation to male rats maintained on a restricted feeding and watering schedule. Both plasma corticosterone and ACTH concentrations fell after the presentation of food and water, and this fall was accompanied by increased levels of ACTH in the pituitary gland. In addition, a rise in plasma levels of ACTH was inhibited in response to an acute stress applied at 0.5 min after presentation of food and water, but ACTH synthesis was not. This inhibition of ACTH and corticosterone secretion in response to stress was transient and dissipated as a relatively linear function of the interval between food presentation and application of the stress. The results suggest that this feeding-induced, corticosteroid-independent inhibition of pituitary-adrenal activity involves active inhibitory mechanisms operating initially on

ACTH secretory processes of the pituitary and later on the synthesis of ACTH or on the secretion of hypothalamic corticotropin-releasing factor.

(Author)

**A79-44300 \*** Computer design synthesis of a below knee-Syme prosthesis. P. T. Elangovan (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands), D. N. Ghista (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.), and R. S. Alwar (Indian Institute of Technology, Madras, India). *Computer Programs in Biomedicine*, vol. 9, Mar. 1979, p. 169-210. 24 refs.

A detailed design synthesis analysis of the BK Syme prosthesis is provided, to determine the socket's cutout orientation size and shape, cutout fillet shape, socket wall thickness distribution and the reinforced fiber distribution in the socket wall, for a minimally stressed structurally safe lightweight prosthesis. For analysis purposes, the most adverse socket loading is obtained at the push-off stage of gait; this loading is idealized as an axial in-plane loading on the bottom edge of the circular cylindrical socket shell whose top edge is considered fixed. Finite element stress analysis of the socket shell (with uniform and graded wall thickness) are performed for various orientations of the cutout and for various types of corner fillets. A lateral cutout with a streamline fillet is recommended. The wall material (i.e., thickness) distribution is determined so as to minimize the stresses, while ensuring that the wall material's stress limits are not exceeded. For such a maximally stressed lightweight socket shell, the panels in the neighborhood of the cutout are checked to ensure that they do not buckle under their acquired stresses. A fiber-reinforced laminated composite socket shell is also analyzed in order to recommend optimum variables in orientations and densities of reinforcing fibers.

(Author)

**A79-44775 \*** Hyperthermia and exercise. J. E. Greenleaf (NASA, Ames Research Center, Laboratory of Human Environmental Physiology, Moffett Field, Calif.). In: *MTP International Review of Physiology*. Volume 20 - Environmental Physiology III. Baltimore, Md., University Park Press, 1979, p. 157-208. 173 refs.

The paper emphasizes fluid and electrolyte parameters that affect the hyperthermia of physical exercise (metabolic heat production). The major hypothesis discussed is that fluid and electrolyte changes influence thermal regulation within the fine control boundaries. A second working hypothesis is that the elevation of core temperature during exercise is a regulated phenomenon that is beneficial to the organism in terms of efficiency and potential for survival and is not merely a failure of the thermoregulatory control system. The central thermoregulatory mechanism seems more responsive to the hypothermic effect of calcium than to the hyperthermic effect of sodium. The mechanisms controlling plasma fluid-electrolyte shifts, particularly during exercise and recovery from exercise, may play an important part in exercise thermoregulation.

S.D.

**A79-44797 \*** Insulin-like effect of bovine growth hormone in vivo as demonstrated by oxidation of C/14-U-glucose in diabetic rats. D. D. Feller and E. D. Neville (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Physiological Chemistry and Physics*, vol. 10, no. 4, 1978, p. 291-304. 14 refs.

**A79-44798 \*** Effects of high-LET neon /Ne-20/ particle radiation on the brain, eyes and other head structures of the pocket mouse - A histological study. L. M. Kraft, M. A. Kelly, J. E. Johnson, Jr., W. Haymaker (NASA, Ames Research Center, Moffett Field; San Francisco, University, San Francisco, Calif.), E. V. Benton, R. P. Henke, R. Cassou (San Francisco, University, San Francisco, Calif.), D. E. Philpott (NASA, Ames Research Center, Moffett Field, Calif.).

F. S. Vogel (Duke University Medical Center, Durham, N.C.), and W. Zeman (Indiana University, Indianapolis, Ind.). *International Journal of Radiation Biology*, vol. 35, no. 1, 1979, p. 33-61. 30 refs. Grant No. NSG-2063; Contract No. NAS2-7927.

**A79-44799 \*** Quantitative analysis of mating behavior in aging male *Drosophila Melanogaster*. A. C. Economos (Technology, Inc., Life Sciences Div., Mountain View, Calif.), J. Miquel, R. Binnard (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.), and S. Kessler (Stanford University, Stanford, Calif.). *Mechanisms of Ageing and Development*, vol. 10, 1979, p. 233-240.

**A79-46651 \*** Eye torsion and visual tilt are mediated by different binocular processes. J. M. Wolfe and R. Held (MIT, Cambridge, Mass.). *Vision Research*, vol. 19, no. 8, 1979, p. 917-920. 10 refs. Grants No. NGL-22-009-308; No. NIH-1-R01-EY-02649; No. NIH-1-T31-GM-07484.

Viewing a large, patterned field rotating about the line of sight produces two measurable effects: cyclotorsion of the eyes (torsion) and a perceived displacement of vertical and horizontal (tilt). Experiments examining binocular interaction for these effects show: (1) both effects demonstrate summation in normal individuals and thus both involve a binocular process; (2) the process for tilt is different than for torsion, since summation for torsion is spared in stereodisjunctive individuals while that for tilt is eliminated. (Author)

**A79-47350 \*** Ion-exchange separation of nucleic acid constituents by high-performance liquid chromatography. E. E. Edelson, J. G. Lawless (NASA, Ames Research Center, Extraterrestrial Biology Div., Moffett Field, Calif.), C. T. Wehr, and S. R. Abbott (Varian Associates, Walnut Creek, Calif.). *Journal of Chromatography*, vol. 174, 1979, p. 409-419. 17 refs.

**A79-47398 \*** The importance of light, postural and social cues in the regulation of the plasma cortisol rhythm in man. J. Vernikos-Danellis and C. M. Winget (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). In: *Chronopharmacology: Proceedings of the Satellite Symposium*, Paris, France, July 21-24, 1978. Oxford, Pergamon Press, Ltd., 1979, p. 101-106. 16 refs.

A series of experiments was conducted to assess the role of photoperiodic, postural and social cues in the regulation of the plasma cortisol rhythm in normal human subjects. Young healthy adult male volunteers, aged 20-25, were used as the test subjects and were selected following extensive physical and psychological examinations. The time at which peak plasma cortisol concentration occurred was calculated from harmonic curves fitted to each set of 24-hr data from each subject. The findings suggest that the plasma cortisol rhythm is not affected appreciably by the absence of postural change, whereas light and social interaction affect this rhythm profoundly. S.D.

**A79-47848 \*** Studies on the bioassayable growth hormone-like activity of plasma. S. Ellis, M. A. Vodian, and R. E. Grindeland (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). In: *Recent progress in hormone research*. Volume 34. New York, Academic Press, Inc., 1978, p. 213-234; Discussion, p. 234-238. 33 refs.

Evidence supporting the existence of bioassayable growth hormone-like activity in blood plasma distinct from the growth hormone measurable by radioimmunoassay and from somatomedin is presented. Tibial assays of the growth-hormone-like activity of

injected, concentrated normal human and rat plasma in hypophysectomized rats reveal 200- and 50-fold activity excesses, respectively, with respect to the amount of growth hormone detected by radioimmunoassay. The origin of this bioassayable plasma hormone has been localized to the region of the pituitary, the origin of growth hormone, a distribution not followed by somatomedin C. Purification of the bioassayable agent indicates that it has a molecular weight of between 60,000 and 80,000, in contrast to that of growth hormone (20,000), and that the bioassayable activity is distinct from that of somatomedin C. Growth hormone-like activity detected in Cohn fraction IV as well as plasma activity, are found to be collectable on Dowex 50 resin, in contrast to somatomedin C and nonsuppressible insulin-like activity. The formation of bioassayable growth hormone-activity agents from radioimmunoassayable growth hormone and directly in the pituitary is suggested. A.L.W.

**A79-47849 \*** Gating effects in *Halobacterium halobium* membrane transport. J. K. Lanyi and M. P. Silverman (NASA, Ames Research Center, Extraterrestrial Research Div., Moffett Field, Calif.). *Journal of Biological Chemistry*, vol. 254, June 10, 1979, p. 4750-4755. 32 refs.

The transport of Na<sup>+</sup> via an H<sup>+</sup>/Na<sup>+</sup> antiporter and of aspartate and serine via Na<sup>+</sup>/amino acid symport systems was studied in *Halobacterium halobium* cell envelope vesicles. Gradients for H<sup>+</sup> were produced by illuminating the bacteriorhodopsin-containing vesicles at different light intensities, and the rate and extent of Na<sup>+</sup> transport were followed as functions of the electrochemical potential difference for protons. The coupling of Na<sup>+</sup> and H<sup>+</sup> gradients suggested a translocation stoichiometry of 2H<sup>+</sup>/Na<sup>+</sup> for the antiporter. The rate of Na<sup>+</sup> transport increases steeply above a critical transmembrane electrochemical proton gradient, and since the electrical and the chemical potentials of H<sup>+</sup> at this threshold point vary with the experimental conditions, while the sum of these potentials is constant, it was concluded that the gating of the Na<sup>+</sup> transport is caused by the total electrochemical gradient. A.T.

**A79-48251 \*** Particle deposition due to turbulent diffusion in the upper respiratory system. P. Hamill (NASA, Ames Research Center, Moffett Field, Calif.; NASA, Langley Research Center, Hampton, Va.; Universidad Católica, Caracas, Venezuela). *Health Physics*, vol. 36, Mar. 1979, p. 355-369. 31 refs. Research supported by the Consejo Nacional de Investigaciones Científicas y Tecnológicas.

Aerosol deposition in the upper respiratory system (trachea to segmental bronchi) is considered and the importance of turbulent diffusion as a deposition mechanism is evaluated. It is demonstrated that for large particles (diameter greater than about 5 microns), turbulent diffusion is the dominant deposition mechanism in the trachea. Conditions under which turbulent diffusion may be important in successive generations of the pulmonary system are determined. The probability of particle deposition is compared with probabilities of deposition, as determined by the equations generally used in regional deposition models. The analysis is theoretical; no new experimental data is presented. (Author)

**A79-49194 \*** Light-driven solute transport in *Halobacterium halobium*. J. K. Lanyi (NASA, Ames Research Center, Moffett Field, Calif.). In: *Microbiology*, Washington, D.C., American Society for Microbiology, 1979, p. 67-71. 29 refs.

The cell membrane of *Halobacterium halobium* exhibits differential regions which contain crystalline arrays of a single kind of protein, termed bacteriorhodopsin. This bacterial retinal-protein complex resembles the visual pigment and, after the absorption of protons, translocates H<sup>+</sup> across the cell membrane, leading to an electrochemical gradient for protons between the inside and the outside of the cell. Thus, light is an alternate source of energy in

these bacteria, in addition to terminal oxidation. The paper deals with work on light-driven transport in *H. halobium* with cell envelope vesicles. The discussion covers light-driven movements of H(+), Na(+), and K(+); light-driven amino acid transport; and apparent allosteric control of amino acid transport. The scheme of energy coupling in *H. halobium* vesicles appears simple, its quantitative details are quite complex and reveal regulatory phenomena. More knowledge is required of the way the coupling components are regulated by the ion gradients present. S.D.

**A79-49985 \*** Deconditioning-induced exercise responses as influenced by heat acclimation. E. Shvartz, A. Bhattacharya, S. J. Sperinde, P. J. Brock, D. Sciaraffa, R. F. Haines, and J. E. Greenleaf (NASA, Ames Research Center, Biomedical Research and Man-Vehicle Systems Research Divs., Moffett Field, Calif.). *Aviation, Space, and Environmental Medicine*, vol. 50, Sept. 1979, p. 893-897. 29 refs.

A study to determine the effect of heat acclimation and physical training in temperate conditions on changes in exercise tolerance following water-immersion deconditioning is presented. Five young men were tested on a bicycle ergometer before and after heat acclimation and after water immersion. The subjects and the experimental procedure, heat acclimation and exercise training, water immersion, and exercise tolerance are discussed. Heat acclimation resulted in the usual decreases in exercise heart rate and rectal temperature and an increase in sweat rate. Water immersion resulted in substantial diuresis despite water consumed. The results show that heat acclimation provides an effective method of preventing the adverse effects of water-immersion deconditioning on exercise tolerance. A.T.

**A79-50205 \*** A simple technique for evaluation of vitality loss in aging mice, by testing their muscular coordination and vigor. J. Miquel and M. Blasco (NASA, Ames Research Center, Moffett Field, Calif.). *Experimental Gerontology*, vol. 13, 1978, p. 389-391. 393-396. 20 refs.

**A79-50227 \*** Modification of a Kowa RC-2 fundus camera for self-photography without the use of mydriatics. D. E. Philpott, G. Harrison, C. Turnbull (NASA, Ames Research Center, Moffett Field, Calif.), and P. F. Bailey (Portland Medical Center, Portland, Ore.). *Brain Research Bulletin*, vol. 4, 1979, p. 123-125.

Research on retinal circulation during space flight required the development of a simple technique to provide self monitoring of blood vessel changes in the fundus without the use of mydriatics. A Kowa RC-2 fundus camera was modified for self-photography by the use of a bite plate for positioning and cross hairs for focusing the subject's retina relative to the film plane. Dilatation of the pupils without the use of mydriatics was accomplished by dark-adaption of the subject. Pictures were obtained without pupil constriction by the use of a high speed strobe light. This method also has applications for clinical medicine. (Author)

**A79-50232 \*** Synaptosomal uptake of hypothalamic monoamines and recovery of pituitary-adrenal activity following medial forebrain bundle lesions in rats. J. P. Heybach, P. A. Brown, and J. Vernikos-Danellis (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *Neuroendocrinology*, vol. 28, 1979, p. 273-280. 22 refs.

**A79-53000 \*** Energy transduction in *Halobacterium halobium*. J. K. Lanyi (NASA, Ames Research Center, Moffett Field, Calif.). In: *Membrane proteins in energy transduction*. New York,

Marcel Dekker, Inc., 1979, p. 451-483. 147 refs.

The properties and functions of the light-energy-transducing purple membrane of *Halobacterium halobium* are reviewed. Consideration is given to the protein structure and composition of the membrane and the photochemistry of the protein-retinal complex known as bacteriorhodopsin. The role of bacteriorhodopsin in establishing and maintaining an electrochemical (H(+)) gradient is examined, and interactions of this gradient with Na(+) and K(+) gradients, the light-induced transport of amino acids and the light-induced phosphorylation of ADP are considered. Bacteriorhodopsin and the respiratory chain are discussed as alternative sources of energy for the maintenance of the H(+) gradient. Advantages of the *Halobacterium* purple membrane system for studies of membrane energetics and the confirmation of the chemiosmotic hypothesis are also noted. A.L.W.

**A79-53291 \*** Bioinstrumentation for evaluation of workload in payload specialists - Results of ASSESS II. H. M. Wegmann, R. Herrmann (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugmedizin, Bonn, West Germany), and C. M. Winger (NASA, Ames Research Center, Biomedical Research Div., Moffett Field, Calif.). *International Astronautical Federation, International Astronautical Congress, 30th, Munich, West Germany, Sept. 17-22, 1979, Paper 79-88*. 17 p. 6 refs.

Results of the medical experiment on payload specialist workloads conducted as part of the ASSESS II airborne simulation of Spacelab conditions are reported. Subjects were fitted with temperature probes and ECG, EKG and EOG electrodes, and hormone and electrolyte excretion was monitored in order to evaluate the changes in circadian rhythms, sleep patterns and stress responses brought about by mission schedules over the ten days of the experiment. Internal dissociations of circadian rhythms, sleep disturbances and increased stress levels were observed, especially during the first three days of the experiment, indicating a considerable workload to be imposed upon the payload specialists. An intensive premission simulation is suggested as a means of estimating overall workloads and allowing payload specialist adaptation to mission conditions. The bioinstrumentation which was developed and applied to the airborne laboratory is concluded to be a practical and reliable tool in the assessment of payload specialist workloads. A.L.W.

## PATENTS

**N79-10182\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PROCESS FOR THE PREPARATION OF CALCIUM SUPER-OXIDE Patent**

E. Vernon Ballou (San Jose State Univ., Calif.), Peter C. Wood (San Jose State Univ., Calif.), Theodore J. Wydeven, and Leroy A. Spitz, inventors (to NASA) (San Jose State Univ., Calif.) Issued 18 Jul. 1978 13 p Filed 11 Jul. 1977 Supersedes N77-29252 (15 - 20, p 2645)

(NASA-Case-ARC-11053-1; US-Patent-4,101,644;

US-Patent-Appl-SN-814378; US-Patent-Class-423-581;

US-Patent-Class-23-252R) Avail: US Patent Office CSCL 07D

Calcium superoxide is prepared in high yields by spreading a quantity of calcium peroxide diperoxhydrate on the surface of a container, positioning said container in a vacuum chamber on a support structure through which a coolant fluid can be circulated, partially evacuating said vacuum chamber, allowing the temperature of the diperoxhydrate to reach the range of about 0 to about 40 C, maintaining the temperature selected for a period of time sufficient to complete the disproportionation of the diperoxhydrate to calcium superoxide, calcium hydroxide, oxygen, and water, constantly and systematically removing the water as it is formed by sweeping the reacting material with a current of dry inert gas and/or by condensation of said water

on a cold surface; backfilling the chamber with a dry inert gas; and finally, recovering the calcium superoxide produced.

Official Gazette of the U.S. Patent Office

**N79-10724\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**CONTOUR DETECTOR AND DATA ACQUISITION SYSTEM FOR THE LEFT VENTRICULAR OUTLINE Patent**

Johan H. C. Reiber, inventor (to NASA) Issued 18 Jul. 1978 19 p Filed 16 Feb. 1977 Supersedes N77-17701 (15 - 06, p 1069)

(NASA-Case-ARC-10985-1; US-Patent-4,101,961; US-Patent-Appl-SN-769148; US-Patent-Class-364-417; US-Patent-Class-358-96; US-Patent-Class-358-111; US-Patent-Class-128-2.05R) Avail: US Patent Office CSCL 06B

A real-time contour detector and data acquisition system is described for an angiographic apparatus having a video scanner for converting an X-ray image of a structure characterized by a change in brightness level compared with its surrounding into video format and displaying the X-ray image in recurring video fields. The real-time contour detector and data acquisition system includes track and hold circuits; a reference level analog computer circuit; an analog comparitor; a digital processor; a field memory; and a computer interface.

Official Gazette of the U.S. Patent Office

**N79-11584#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**SUBCUTANEOUS CHANNELING PROBE Patent Application**

Gordon F. Lund (NAC-NRC), Richard C. Simmonds, and Bill A. Williams, inventors (to NASA) Filed 31 Oct. 1978 12 p (NASA-Case-ARC-11091-1; US-Patent-Appl-SN-956162) Avail: NTIS HC A02/MF A01 CSCL 06B

The subcutaneous channeling probe 15 provided an instrument for use in the placement of biosensors with long leads in animals. The probe channeled subcutaneously through connective tissue from the site of lead entry 4 to the site of biosensor placement. After securing a sensor to the end of the probe, the probe was pulled out of an exit incision 5, guiding the biosensor and lead into place. The probe was constructed of flexible rod material, such as standard 9.5 mm (3/8 inch) nylon rod and was provided with blunted pointed tips; spearhead tip 8 and tapered end tip 9. This design permitted the efficient channeling of the instrument through connective tissue when force was exerted through the rod. However, because of the blunted edges 19 and tips, the actual cutting of the connective tissue was kept to a minimum. Further, the probe was constructed in sections 16, 17, and 18. NASA

**N79-14188\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**MICROELECTROPHORETIC APPARATUS AND PROCESS Patent**

Benjamin W. Grunbaum, inventor (to NASA) (Calif. Univ., Berkeley) Issued 19 Dec. 1978 14 p Filed 10 Nov. 1977 Supersedes N78-11216 (16 - 02, p 0172) Sponsored by NASA (NASA-Case-ARC-11121-1; US-Patent-4,130,471; US-Patent-Appl-SN-850507; US-Patent-Class-204/180G; US-Patent-Class-204-180S; US-Patent-Class-204-299R; US-Patent-Class-23-230B; US-Patent-Class-424-12) Avail: US Patent and Trademark Office CSCL 07D

New gel tray and lid assemblies designed for use in conjunction with slotted electrophoretic membranes were developed to take advantage of recently improved microelectrophoretic accessories which include a multisample applicator capable of applying up to 10 samples consecutively or simultaneously, and a temperature control plate for dissipating the heat produced by electrophoresis in a gel. The trays and membranes can be marketed ready for use as electrophoretic media or impregnated with various specific substrates and dyes.

Official Gazette of the U.S. Patent and Trademark Office

**N79-14214\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**PREPARATION OF DIELECTRIC COATING OF VARIABLE DIELECTRIC CONSTANT BY PLASMA POLYMERIZATION Patent**

Martin Hudis (Allis-Chalmers, Milwaukee) and Theodore Wydeven, inventors (to NASA) Issued 2 Jan. 1979 8 p Filed 11 Feb. 1977 Supersedes N77-17245 (15 - 08, p 1010) Division of abandoned US Patent Appl. SN-589172, filed 23 Jun. 1975 (NASA-Case-ARC-10892-2; US-Patent-4,132,829; US-Patent-Appl-SN-767912; US-Patent-Class-428-411; US-Patent-Class-427-41; US-Patent-Class-427-294; US-Patent-Appl-SN-589172) Avail: US Patent and Trademark Office CSCL 07C

A plasma polymerization process for the deposition of a dielectric polymer coating on a substrate comprising disposing of the substrate in a closed reactor between two temperature controlled electrodes connected to a power supply is presented. A vacuum is maintained within the closed reactor, causing a monomer gas or gas mixture of a monomer and diluent to flow into the reactor, generating a plasma between the electrodes. The vacuum varies and controls the dielectric constant of the polymer coating being deposited by regulating the gas total and partial pressure, the electric field strength and frequency, and the current density.

Official Gazette of the U.S. Patent and Trademark Office

**N79-14755#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**INDOMETHACIN-ANTIHISTAMINE COMBINATION FOR GASTRIC ULCERATION CONTROL Patent Application**

Patricia A. Brown (San Jose State Univ., Calif.) and Joan Vernikos-Danellis, inventors (to NASA) Filed 29 Dec. 1978 19 p (NASA-Case-ARC-11118-2; US-Patent-Appl-SN-974476) Avail: NTIS HC A02/MF A01 CSCL 06E

Gastric ulcers caused by the ingestion of indomethacin by subjects under stress are significantly reduced by administering to the subjects, together or in sequence, such antihistaminic drugs as pyrilamine, promethazine, metiamide, or cimetidine. The dosages may range from 25 to 200 mg daily for the indomethacin and from 200 mg to 1.5 g daily for the antihistamine. NASA

**N79-15245\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**ELECTRIC DISCHARGE FOR TREATMENT OF TRACE CONTAMINANTS Patent**

Daniel L. Flamm (Stanford Univ., Calif.) and Theodore J. Wydeven, Jr., inventors (to NASA) Issued 19 Dec. 1978 9 p Filed 23 May 1977 Supersedes N77-24771 (15 - 15, p 2033) (NASA-Case-ARC-10975-1; US-Patent-4,130,490; US-Patent-Appl-SN-799832; US-Patent-Class-250-531; US-Patent-Class-250-540; US-Patent-Class-250-541) Avail: US Patent and Trademark Office CSCL 09C

A radio frequency glow discharge reactor is described for removing trace oxidizable contaminants from an oxygen bearing atmosphere. The reaction chamber is defined by an inner metal electrode facing a dielectric backed by an outer conductive electrode. In one embodiment, a conductive liquid forms the conductor of an outer electrode and cools the dielectric. A resonator coupled to a variable radio frequency source generates the high voltages for creating a glow discharge in the chamber at a predetermined pressure whereby the trace contaminants are oxidized into a few simple non-toxic products that may be easily recovered. The corresponding process for removal of trace contaminants from an oxygen-bearing atmosphere with high efficiency independent of the concentration level is also disclosed. Official Gazette of the U.S. Patent and Trademark Office

**N79-18052\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**OXYGEN POST-TREATMENT OF PLASTIC SURFACE**

**COATED WITH PLASMA POLYMERIZED SILICON-CONTAINING MONOMERS Patent**

Theodore J. Wydeven and John R. Hollanhan, Jr., inventors (to NASA) Issued 30 Jan 1979 5 p Filed 21 Mar 1977 Supersedes N77-20256 (15 - 11, p 1433) Continuation-in-part of abandoned US Patent Appl. SN-634304, filed 21 Nov 1975 (NASA-Case-ARC-10915-2; US-Patent-4,137,365; US-Patent-Appl-SN-779883; US-Patent-Class-428-412; US-Patent-Class-427-40; US-Patent-Class-427-41; US-Patent-Class-428-447; US-Patent-Class-428-451; US-Patent-Appl-SN-634304) Avail: US Patent and Trademark Office CSCL 11B

The abrasion resistance of plastic surfaces coated with polymerized organosilanes can be significantly improved by post-treatment of the polymerized silane in an oxygen plasma. For optical purposes, the advantages of this post-treatment are developed with a transparent polycarbonate resin substrate coated with plasma polymerized vinyltrimethoxysilane.

Official Gazette of the U.S. Patent and Trademark Office

**N79-30921\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.**

**SPINE IMMOBILIZATION METHOD AND APPARATUS Patent Application**

Kenneth H. Lambson (Lambson, Kenneth and Assoc., San Diego, Calif.) and Hubert C. Vykukal, inventors (to NASA) Filed 13 Jul 1979 16 p (NASA-Case-ARC-11167-1; US-Patent-Appl-SN-057526) Avail: NTIS HC A02/MF A01 CSCL 06B

A spine immobilization apparatus which uses a normally flat, flexible bladder filled with beads or microballoons is described. The beads form a rigid mass when the pressure within the bladder is decreased below ambient through the use of a suction pump. The bladder can be conformed to the victim's torso to provide the desired restraint. It is strapped to the victim prior to being rigidified by an arrangement of straps which avoid the stomach area. The bladder is adapted to be secured to a rigid support, i.e., a rescue chair, so as to enable removal of a victim after the bladder has been made rigid. A double sealing connector is used to connect the bladder to the suction pump and a control valve is employed to vary the pressure within the bladder so as to soften and harden the bladder as desired.

NASA

**N79-24651\* National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.**

**SPACESUIT MOBILITY KNEE JOINTS Patent**

Hubert C. Vykukal, inventor (to NASA) Issued 1 May 1979 19 p Filed 3 Mar 1978 Supersedes N78-18763 (16 - 09, p 1209) Division of US Patent Appl. SN-753965, filed 23 Dec 1976, US Patent-4,091,464 (NASA-Case-ARC-11058-2; US-Patent-4,151,612; US-Patent-Appl-SN-883094; US-Patent-Class-2-2 1A; US-Patent-Class-285-235; US-Patent-4,091,464; US-Patent-Appl-SN-753965) Avail: US Patent and Trademark Office CSCL 05H

Pressure suit mobility joints are for use in interconnecting adjacent segments of an hermetically sealed spacesuit in which low torques, low leakage and a high degree of reliability are required. Each of the joints is a special purpose joint characterized by substantially constant volume and low torque characteristics and includes linkages which restrain the joint from longitudinal distension and includes a flexible, substantially impermeable diaphragm of tubular configuration spanning the distance between pivotally supported annuli. The diaphragms of selected joints include rolling convolutions for balancing the joints, while various joints include wedge-shaped sections which enhance the range of motion for the joints.

Official Gazette of the U.S. Patent and Trademark Office

**N79-33220\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.**

**ENVIRONMENTAL FOG/RAIN VISUAL DISPLAY SYSTEM FOR AIRCRAFT SIMULATORS Patent Application**

Wendell D. Chase, inventor (to NASA) Filed 29 Jun 1979 62 p (NASA-Case-ARC-11158-1; US-Patent-Appl-SN-053566) Avail: NTIS HC A07/MF A01 CSCL 14B

A combination of electronic and mechanical integrated elements which operate together are used to produce realistic environmental conditions that would actually be encountered by a pilot flying an aircraft. The electronic elements of the system include a real time digital computer, a calligraphic color display which simulates landing lights of selective intensity, and a color television camera for producing a moving color display of the airport runway as depicted on a model terrain board. The mechanical simulation elements of the system include an environmental chamber which can produce natural fog, nonhomogeneous fog, rain and fog combined, or rain only. A pilot looking through the aircraft windscreen will look through the fog and/or rain generated in the environmental chamber on to a viewing screen with the simulated color image of the airport runway, and observe a very real simulation of actual conditions of a runway as it would appear through actual fog and/or rain.

NASA

**N79-28551\* National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.**

**CONTROLLER ARM FOR A REMOTELY RELATED SLAVE ARM Patent**

John K. Salisbury, Jr., inventor (to NASA) (Stanford Univ., Calif.) Issued 10 Jul 1979 11 p Filed 19 Aug 1977 Supersedes N77-30751 (15 - 21, p 2841) Sponsored by NASA (NASA-Case-ARC-11052-1; US-Patent-4,160,508; US-Patent-Appl-SN-826202; US-Patent-Class-414-4) Avail: US Patent and Trademark Office CSCL 13I

A segmented controller arm configured and dimensioned to form a miniature kinematic replica of a remotely related slave arm is disclosed. The arm includes: (1) a plurality of joints for affording segments of the arm simultaneous angular displacement about a plurality of pairs of intersecting axes, (2) a plurality of position sensing devices for providing electrical signals indicative of angular displacement imparted to corresponding segments of the controller shaft about the axes, and (3) a control signal circuit for generating control signals to be transmitted to the slave arm. The arm is characterized by a plurality of yokes, each being supported for angular displacement about a pair of orthogonally related axes and counterbalanced against gravitation by a cantilevered mass.

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## RESEARCH SUPPORT

### FORMAL REPORTS

**N79-19022\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### AIRCRAFT FLIGHT SIMULATION OF SPACELAB EXPERIMENT USING AN IMPLANTED TELEMETRY SYSTEM TO OBTAIN CARDIOVASCULAR DATA FROM THE MONKEY

c51

E. P. McCutcheon, R. Miranda, T. B. Fryer, G. Hodges, B. D. Newson, and N. Pace *In NASA. Goddard Space Flight Center Ninth Conf. on Space Simulation 1977 p 141-153 refs (For primary document see N79-19013 10-12)*

Avail: NTIS HC A20/MF A01 CSCL 06B

The utility of a multichannel implantable telemetry system for obtaining cardiovascular data was tested in a monkey with a CV-990 aircraft flight simulation of a space flight experiment. Valuable data were obtained to aid planning and execution of flight experiments using chronically instrumented animals. Author

Avail: NTIS HC A11/MF A01 CSCL 20K

A 91.5 cm aperture telescope installed aboard NASA-Lockheed C-141A aircraft for the performance of infrared astronomy is described. A unique feature of the telescope is that its entire structure is supported by a 41 cm spherical air bearing which effectively uncouples it from aircraft angular motion, and with inertial stabilization and star tracking, limits tracking errors to less than 1 arc second in most applications. A general description of the system, a summary of its performance, and a detailed description of an offset tracking mechanism is presented.

J.M.S.

**N79-20185\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### CALORIMETER PROBES FOR MEASURING HIGH THERMAL FLUX

Larry D. Russell Apr. 1979 13 p  
(NASA-TM-78573; A-7772) Avail: NTIS HC A02/MF A01 CSCL 14B

Expendable, slug-type calorimeter probes were developed for measuring high heat-flux levels of 10-30 kW/sq cm in electric-arc jet facilities. The probes were constructed with thin tungsten caps mounted on Teflon bodies. The temperature of the back surface of the tungsten cap is measured, and its time rate of change gives the steady-state absorbed heat flux as the calorimeter probe heats to destruction when inserted into the arc jet. Design, construction, test, and performance data are presented. S.E.S.

**N79-21381\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### TWO-DIMENSIONAL OSCILLATING AIRFOIL TEST APPARATUS

Frank L. Gibson, Andrew J. Hocker, Jr., and Dennis S. Matsuhiro *In NASA. Goddard Space Flight Center The 11th Aerospace Mech. Symp. 28 Apr. 1977 p 177-184 (For primary document see N79-21374 12-37)*

Avail: NTIS HC A11/MF A01 CSCL 20K

A two dimensional oscillating airfoil test apparatus is presented as a method of measuring unsteady aerodynamic forces on an airfoil or rotor blade section. The oscillating airfoil test rig, which is being built for use in an 11 X 11-foot transonic wind tunnel (speed range M = 0.4 - 1.4), will allow determination of unsteady loadings and detailed pressure distributions on representative airfoil sections undergoing simulated pitching and flapping motions. The design details of the motion generating system and supporting structure are presented. This apparatus is now in the construction phase.

J.A.M.

**N79-21364\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### ADVANCED VEHICLE SEPARATION APPARATUS

Michael J. O'Spring and Ronald E. Mancini *In its The 12th Aerospace Mech. Symp. Apr. 1979 p 131-141 (For primary document see N79-21352 12-37)*

Avail: NTIS HC A11/MF A01 CSCL 20K

A method of obtaining test data from two independent models or bodies in a conventional wind tunnel is described. The system makes efficient use of wind tunnel test time with computer control performing complex coordinate transformations necessary for model positioning. The apparatus is designed to be used in any of the three Unitary Wind Tunnels at NASA-Ames Research Center. Mechanical design details and a brief description of the control system for the separation apparatus are presented. J.M.S.

**N79-21822\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### NASF TRANSPOSITION NETWORK: A COMPUTING NETWORK FOR UNSCRAMBLING p-ORDERED VECTORS

Raymond S. Lim Apr. 1979 37 p refs  
(NASA-TP-1426; A-7645) Avail: NTIS HC A03/MF A01 CSCL 09B

The viewpoints of design, programming, and application of the transportation network (TN) is presented. The TN is a programmable combinational logic network that connects 512 memory modules to 512 processors. The unscrambling of p-ordered vectors to 1-ordered vectors in one cycle is described. The TN design is based upon the concept of cyclic groups from abstract algebra and primitive roots and indices from number theory. The programming of the TN is very simple, requiring only 20 bits: 10 bits for offset control and 10 bits for barrel switch shift control. This simple control is executed by the control unit (CU), not the processors. Any memory access by a processor must be coordinated with the CU and wait for all other processors to come to a synchronization point. These wait and synchronization events can be a degradation in performance to a computation. The TN application is for multidimensional data manipulation, matrix processing, and data sorting, and can also perform a perfect shuffle. Unlike other more complicated and powerful permutation networks, the TN cannot, if possible at all, unscramble non-p-ordered vectors in one cycle.

S.E.S.

**N79-21373\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

#### NASA-ARC 91.6-cm AIRBORNE INFRARED TELESCOPE

Robert E. Mobley and Ted M. Brown *In its The 12th Aerospace Mech. Symp. Apr. 1979 p 233-242 refs (For primary document see N79-21352 12-37)*

**N79-22546#** National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**DESIGN OF A PIEZOELECTRIC SHAKER FOR CENTRIFUGE  
TESTING**

Jeffrey G. Canclini and Jerald M. Henderson (California Univ., Davis) /n NASA Johnson Space Center. The 13th Aerospace Mech. Symp. 1979 p 59-70 refs (For primary document see N79-22539 13-39)

Avail: NTIS HC A13/MF A01 CSCL 13I

The design of a prototype piezoelectric shaker and its development to date is described. Although certain design problems remain to be solved, the piezoelectric system shows promise for adaptation to a larger payload system, such as the proposed geotechnical centrifuge at the Ames Research Center. J.A.M.

**N79-22547#** National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**HELICAL GRIP FOR THE CABLE CARS OF SAN FRANCISCO**

Richard J. Peyran /n NASA Johnson Space Center. The 13th Aerospace Mech. Symp. 1979 p 83-93 refs (For primary document see N79-22539 13-39)

Avail: NTIS HC A13/MF A01 CSCL 13I

A helical cable car grip to minimize high maintenance costs of San Francisco's cable car operation is presented. The grip establishes a rolling contact between the cable and grip to reduce sliding friction and associated cable wear. The design, development, and testing of the helical cable car grip are described.

J.A.M.

**N79-26762#** National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**A LONG-RANGE AND LONG-LIFE TELEMETRY DATA-  
ACQUISITION SYSTEM FOR HEART RATE AND MULTIPLE  
BODY TEMPERATURES FROM FREE-RANGING ANIMALS**

Gordon F. Lund (San Jose State Univ.), Richard M. Westbrook, Thomas B. Fryer, and Rafael F. Miranda May 1979 74 p refs

(NASA-TM-78590, A-7824) Avail: NTIS HC A04/MF A01 CSCL 06B

The system includes an implantable transmitter, external receiver-retransmitter collar, and a microprocessor-controlled demodulator. The size of the implant is suitable for animals with body weights of a few kilograms or more; further size reduction of the implant is possible. The ECG is sensed by electrodes designed for internal telemetry and to reduce movement artifacts. The R-wave characteristics are then specifically selected to trigger a short radio frequency pulse. Temperatures are sensed at desired locations by thermistors and then, based on a heartbeat counter, transmitted intermittently via pulse interval modulation. This modulation scheme includes first and last calibration intervals for a reference by ratios with the temperature intervals to achieve good accuracy even over long periods. Pulse duration and pulse sequencing are used to discriminate between heart rate and temperature pulses as well as RF interference.

Author

**N79-30947#** National Aeronautics and Space Administration.  
Ames Research Center, Moffett Field, Calif.

**CONCURRENT ERROR DETECTING CODES FOR ARITHMETIC  
PROCESSORS**

Raymond S. Lim Aug 1979 27 p refs

(NASA-TP-1528, A-7810) Avail: NTIS HC A03/MF A01 CSCL 09B

A method of concurrent error detection for arithmetic processors is described. Low-cost residue codes with check-length  $l$  and checkbase  $m = 2$  to the  $l$  power - 1 are described for checking arithmetic operations of addition, subtraction, multiplication, division, complement, shift, and rotate. Of the three number representations, the signed-magnitude representation is

preferred for residue checking. Two methods of residue generation are described: the standard method of using modulo  $m$  adders and the method of using a self-testing residue tree. A simple single-bit parity-check code is described for checking the logical operations of XOR, OR, and AND, and also the arithmetic operations of complement, shift, and rotate. For checking complement, shift, and rotate, the single-bit parity-check code is simpler to implement than the residue codes. G.Y.

R

## NASA CONTRACTOR REPORTS

**N79-12417#** Control Technology Associates, Cupertino, Calif.  
**LABORATORY DEMONSTRATION OF AIRCRAFT ESTIMA-**

**TION USING LOW-COST SENSORS** Final Report

John A. Sorensen [1978] 84 p refs

(Contract NAS2-9382)

(NASA-CR-152049) Avail: NTIS HC A05/MF A01 CSCL 14B

Four nonlinear state estimators were devised which provide techniques for obtaining the angular orientation (attitude) of the aircraft. An extensive FORTRAN computer program was developed to demonstrate and evaluate the estimators by using recorded flight test data. This program simulates the estimator operation, and it compares the state estimates with actual state measurements. The program was used to evaluate the state estimators with data recorded on the NASA Ames CV-580 and CESSNA 402B aircraft. A preliminary assessment was made of the memory, word length, and timing requirements for implementing the selected state estimator on a typical microcomputer. G.Y.

**N79-24567#** Washington Univ., Seattle. Dept. of Atmospheric Sciences.

**MIDDLE ATMOSPHERE PROJECT. A SEMI-SPECTRAL  
NUMERICAL MODEL FOR THE LARGE-SCALE STRATO-  
SPHERIC CIRCULATION**

James R. Holton and William Wehrbein May 1979 78 p refs

(Grant NsG-2228)

(NASA-CR-158653, Rept-1) Avail: NTIS HC A05/MF A01 CSCL 04A

The complete model is a semispectral model in which the longitudinal dependence is represented by expansion in zonal harmonics while the latitude and height dependencies are represented by a finite difference grid. The model is based on the primitive equations in the log pressure coordinate system. The lower boundary of the model domain is set at the 100 mb level (i.e., near the tropopause) and the effects of tropospheric forcing are included in the lower boundary condition. The upper boundary is at approximately 96 km, and the latitudinal extent is either global or hemispheric. The basic differential equations and boundary conditions are outlined. The finite difference equations are described. The initial conditions are discussed and a sample calculation is presented. The FORTRAN code is given in the appendix. G.Y.

**N79-24957#** Informatics, Inc., Palo Alto, Calif.

**COMPUTATIONS OF UNSTEADY TRANSONIC FLOW  
GOVERNED BY THE CONSERVATIVE FULL POTENTIAL  
EQUATION USING AN ALTERNATING DIRECTION IMPLIC-  
IT ALGORITHM**

Peter M. Goorjian Jun 1979 48 p refs

(Contract NAS2-9891)

(NASA-CR-152274) Avail: NTIS HC A03/MF A01 CSCL 01A

A development was the time linearization of the density function. This linearization reduces the solution process from solving just a single equation. Two sample cases were computed. First, a one dimensional traveling shock wave was computed and compared with the analytic solution. Second, a two dimensional case was calculated for a flow field which resulted

from a thickening and subsequently, thinning airfoil. The resulting flow field, which included a traveling shock wave, was compared to the flow field obtained from the low frequency, small disturbance, transonic equation.

J.A.M.

N79-26070# Control Data Corp., St. Paul, Minn. Research and Advanced Design Lab

**FEASIBILITY STUDY FOR A NUMERICAL AERODYNAMIC SIMULATION FACILITY. VOLUME 3: FMP LANGUAGE SPECIFICATION/USER MANUAL Final Report**

B. G. Kenner and N. R. Lincoln May 1979 263 p 4 Vol. (Contract NAS2-9698) (NASA-CR-152289) Avail. NTIS HC A12/MF A01 CSCL 14B

The manual is intended to show the revisions and additions to the current STAR FORTRAN. The changes are made to incorporate an FMP (Flow Model Processor) for use in the Numerical Aerodynamic Simulation Facility (NASF) for the purpose of simulating fluid flow over three-dimensional bodies in wind tunnel environments and in free space. The FORTRAN programming language for the STAR-100 computer contains both CDC and unique STAR extensions to the standard FORTRAN. Several of the STAR FORTRAN extensions to standard FORTRAN allow the FORTRAN user to exploit the vector processing capabilities of the STAR computer. In STAR FORTRAN, vectors can be expressed with an explicit notation, functions are provided that return vector results, and special call statements enable access to any machine instruction.

G.Y.

## JOURNAL ARTICLES, BOOKS AND CHAPTERS OF BOOKS

R

A79-17591 \* Real time mass flow computer for Arc Jet Wind Tunnel. J. Vidal (NASA, Ames Research Center, Moffett Field, Calif.). In: International Instrumentation Symposium, 24th, Albuquerque, N. Mex., May 1-5, 1978. Proceedings. Part 1. (A79-17576 05-35) Pittsburgh, Pa., Instrument Society of America, 1978, p. 217-221. 6 refs.

Experiments at the Arc-Jet Tunnel at Ames Research Center have typical run times of 5-10 sec during which the test model is subjected to an environment simulating reentry into Jupiter. Previous real-time determination of mass flow required off-line manual computations from taped or strip chart data. The present paper describes a computer which provides personnel with real-time computations of mass flow. Using an 8-bit microprocessor and standard TTL interface circuitry, the unit interrogates temperature and pressure instruments with other parameters to compute mass flow.

B.J.

A79-20057 \* On the mean meridional mass motions of the stratosphere and mesosphere. T. Dunkerton (Washington, University, Seattle, Wash.). *Journal of the Atmospheric Sciences*, vol. 35, Dec. 1978, p. 2325-2333. 52 refs. Grant No. NSG-2228.

Using a simplified, approximate 'Lagrangian-mean' dynamical formulation, the mean meridional mass circulation of the stratosphere and mesosphere is discussed. Under solstice conditions, it is shown that this Lagrangian-mean circulation may be inferred, as a first approximation, from the Eulerian-mean diabatic heating. Diabatic heating rates for the solstices, originally derived by Murgatroyd and Goody (1958), result in Lagrangian-mean rising motion at the tropical tropopause, subsidence across the extra-tropical tropopause, and a very strong summer-to-winter pole flow in the mesosphere. This circulation is exactly that obtained by Murgatroyd and Singleton (1961) for the solstices. Those authors, however, attempted to identify this circulation as the Eulerian-mean motion, and were later criticized for their neglect of the meridional eddy heat flux in the

calculation, which proved to be extremely important in the winter hemisphere. The present study, nevertheless, indicates that Murgatroyd and Singleton's circulation may in fact be representative of actual air parcel motions in the stratosphere and mesosphere.

(Author)

A79-23669 \* An unusually large westerly amplitude of the quasi-biennial oscillation. L. Coy (Washington, University, Seattle, Wash.). *Journal of the Atmospheric Sciences*, vol. 36, Jan. 1979, p. 174-176. Grant No. NSG-2228.

A time-height section of the quasi-biennial oscillation is presented for the period 1950-1978. The data are from the Canal Zone station through June 1970 and from Kwajalein from July 1970 through April 1978 (both stations are near 9 deg N). The most striking feature in the new data is the unusually strong westerly phase which occurred in the winter of 1977-1978. The magnitude of the westerly amplitude in December 1978 was over 60 m/sec at and above 10 mb. The easterly phase below the westerly phase of the 1977-1978 winter was also unusually large. The other features in the new data are consistent with past observations.

B.J.

A79-24154 \* Plasma waves near Venus - Initial observations. F. L. Scarf, W. W. L. Taylor, and I. M. Green (TRW Defense and Space Systems Group, Redondo Beach, Calif.). *Science*, vol. 203, Feb. 23, 1979, p. 748-750. 9 refs. Contracts No. NAS2-8809, No. NAS2-9842.

The Pioneer Venus electric field detector was used to observe significant effects of the interaction of the solar wind with the ionosphere of Venus all along the orbiter trajectory. Information on sharp and diffuse shock structures and on plasma oscillations emitted by suprathermal electrons beyond the bow shock is considered, and wave-particle interaction phenomena important near the boundary of the dayside ionosphere are noted.

M.L.

A79-24170 \* Preliminary results of the Pioneer Venus nephelometer experiment. B. Ragent (NASA, Ames Research Center, Moffett Field, Calif.) and J. Blamont (CNRS, Service d'Aéronomie, Verrières-le-Buisson, Essonne, France). *Science*, vol. 203, Feb. 23, 1979, p. 790-792. 7 refs.

Preliminary results of the nephelometer experiments conducted aboard the large sounder, day, north, and night probes of the Pioneer Venus mission are presented. The vertical structures of the Venus clouds observed simultaneously at each of the four locations from altitudes of from 63 kilometers to the surface are compared, and similarities and differences are noted. Tentative results from attempting to use the data from the nephelometer and cloud particle size spectrometer on the sounder probe to identify the indices of refraction of cloud particles in various regions of the Venus clouds are reported. Finally the nephelometer readings for the day probe during impact on the surface of Venus are presented.

(Author)

A79-28074 \* Data processing in infrared astronomy. R. F. Peizmann, Jr. (NASA, Ames Research Center, Institute for Advanced Computation, Moffett Field, Calif.). In: Modern utilization of infrared technology IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978. (A79-28069 10-35) Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 36-42. 7 refs.

Infrared astronomy is often carried out with rocket probes or orbiting satellite telescopes in order to escape the effects of atmospheric absorption. The data returned from such missions is a highly abstracted digital representation of measurements made by analog detectors. The ability to extract infrared-emission information from these data streams depends on a thorough understanding of the information flow from the telescope aperture to the computer center. This paper reviews the primary elements of this end-to-end

concept and the impact of each of these elements on the data processing algorithms, including the division between onboard and ground processing for scientific measurements.

B.J.

**A79-34240 \*** **Autocorrelation of X-ray bright points with sunspot number, 1970-1978.** L. Golub (Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass.), J. M. Davis, and A. S. Krieger (American Science and Engineering, Inc., Cambridge, Mass.). *Astrophysical Journal, Part 2 - Letters to the Editor*, vol. 229, May 1, 1979, p. L145-L150. 15 refs. Contracts No. NASW-2027; No. NAS-7424; No. NAS-8683; No. NAS-27758; No. NAS-8-31374.

Soft X-ray observations of the solar corona over the period 1970-1978 show that the number of small short-lived bipolar magnetic features (X-ray bright points) varies inversely with the sunspot index. During the entire period from 1973 to 1978 most of the magnetic flux emerging at the solar surface appeared in the form of bright points. In 1970, near the peak of solar cycle 20, the contributions from bright points and from active regions appear to be approximately equal. These observations strongly support an earlier suggestion that the solar cycle may be characterized as an oscillator in wave-number space with relatively little variation in the average total rate of flux emergence.

(Author)

**A79-40279 \*** **A (31,15) Reed-Solomon Code for large memory systems.** R. S. Lim (NASA, Ames Research Center, Moffett Field, Calif.). In: National Computer Conference, New York, N.Y., June 4-7, 1979, Proceedings. (A79-40276 17-59) Montvale, N.J., AFIPS Press, 1979, p. 205-208. 12 refs.

This paper describes the encoding and the decoding of a (31,15) Reed-Solomon Code for multiple-burst error correction for large memory systems. The decoding procedure consists of four steps: (1) syndrome calculation, (2) error-location polynomial calculation, (3) error-location numbers calculation, and (4) error values calculation. The principal features of the design are the use of a hardware shift register for both high-speed encoding and syndrome calculation, and the use of a commercially available (31,15) decoder for decoding Steps 2, 3 and 4.

(Author)

**A79-40818 \*** **Further results of the Pioneer Venus nephelometer experiment.** J. Blamont (CNRS, Service d'Aéronomie, Verrières-le-Buisson, Essonne, France) and B. Ragent (NASA, Ames Research Center, Moffett Field, Calif.). *Science*, vol. 205, July 6, 1979, p. 67-70. 9 refs.

Backscattering data for the nephelometer experiments conducted aboard the Pioneer Venus mission probes, including data up to the highest altitudes measured by the probes, are presented. A few small signals were detected below the main cloud deck. Ambient radiation was measured at near-ultraviolet and visible wavelengths; the variation of extinction of near-ultraviolet with altitude is inferred. Ambient radiance decreased more rapidly at 530 than at 745 nanometers in the lower atmosphere.

(Author)

**A79-41400 \*** **Telemetry of intracranial pressure.** T. B. Fryer, S. D. Corbin, G. D. Silverberg, E. V. Schmidt, and A. K. Ream (NASA, Ames Research Center, Moffett Field, Stanford University, Stanford, Calif.). *Biotelemetry and Patient Monitoring*, vol. 5, no. 2, 1978, p. 88-112. 33 refs. Grant No. NGR-05-020-634.

A completely implantable epidural pressure telemetry system designed for accurate measurement of intracranial pressure (ICP) is described. The implant device is batteryless, providing unlimited operating life. The described system uses a capacitive pressure transducer with excellent long-term stability. Once detected with the transducer and converted to a frequency with the oscillator electronics, the pressure signal is digitized. It is then telemetered without the possibility of further degradation. After detection with

the small external module, the data can be retransmitted by a radio link for complete patient mobility or the energizer signal pickup module can be wired to a bedside readout unit. Continuous data are available from the system so that the dynamic ICP changes reflecting arterial blood pressure can be observed and used for diagnosis. S.D.

**A79-41424 \*** **An inductively powered telemetry system for temperature, EKG, and activity monitoring.** T. B. Fryer, G. F. Lund, and B. A. Williams (NASA, Ames Research Center, Moffett Field, Calif.). *Biotelemetry and Patient Monitoring*, vol. 5, no. 2, 1978, p. 53-76. 10 refs. Grant No. NSG-2293.

An implant telemetry system for the simultaneous monitoring of temperature, activity, and EKG from small animals, such as rats, has recently been designed with the novel feature that instead of a battery the system is energized by an inductive field. A 250 kHz resonant coil surrounds the cage (30 x 30 x 20 cm) and provides the approximately 100 microwatt of power required to operate the implant transmitter while allowing the animal unrestrained movement in the cage. The implant can also be battery operated if desired. RF transmission is in the 8-10 MHz band, which allows the use of a simple, essentially single IC chip, receiver.

(Author)

**A79-43930 \*** **Equatorial wave-mean flow interaction - A numerical study of the role of latitudinal shear.** J. R. Holton (Washington University, Seattle, Wash.). *Journal of the Atmospheric Sciences*, vol. 36, June 1979, p. 1030-1040. 13 refs. NSF Grant No. ATM-76-84633; Grant No. NSG-2228.

A time-dependent primitive equation model for an equatorial channel is used to assess the interaction of equatorial Kelvin and mixed Rossby-gravity waves with the mean flow. The proposed model involves a semiimplicit time-differencing scheme and a finite-difference grid in the meridional plane. It is shown that forced equatorial waves interact with mean flow to produce equatorial jets characterized by downward-moving westerly (Kelvin wave forcing) and easterly (mixed Rossby-gravity wave forcing) shear zones, respectively. For parameters characteristic of the observed waves in the equatorial stratosphere, the wave-mean flow interaction process always reduces the amplitude of any initial cross-equatorial mean wind shear. The mean flow profile tends to become symmetric about the equator as the interaction process continues.

S.D.

**A79-48218 \*** **A possible 2-day oscillation near the tropical stratopause.** L. Coy (Washington University, Seattle, Wash.). *Journal of the Atmospheric Sciences*, vol. 36, Aug. 1979, p. 1615-1618. 6 refs. Grant No. NSG 2228.

An examination of daily meteorological rocket data taken during January and February 1977 at Kwajalein, Marshall Islands (9 deg N, 168 deg E) suggests the presence of a large oscillation in the meridional wind with a period near 2 days. Some rocket data taken concurrently at other stations is also presented. The Canal Zone station (9 deg N, 80 deg W) suggests a possible 2-day oscillation, while middle- and high-latitude stations show variability with periods ranging from 2-5 days.

(Author)

**A79-49720 \* # On-axis velocity component measurement with laser velocimeters.** S. Neti and W. Clark (NASA, Ames Research Center, Electronic Instrument Development Branch, Moffett Field, Calif.). *AIAA Journal*, vol. 17, Sept. 1979, p. 1013-1015. 11 refs.

The application of Doppler shifted laser light to the measurement of the two velocity components normal to the optical axis of the system is relatively simple as compared to the measurement of the on-axis velocity component. The present paper deals with the reference-beam (local oscillator) technique and the dual-beam (fringe mode) technique, which have been developed for measuring the on-axis component. Some results obtained for the on-axis component are examined.

V.P.

**A79-51499\*** Oxides of nitrogen and the clouds of Venus. A. J. Watson, T. M. Donahue, D. H. Stedman (Michigan University, Ann Arbor, Mich.), R. G. Knollenberg (Particle Measuring Systems, Inc., Boulder, Colo.), B. Ragent (NASA, Ames Research Center, Moffett Field, Calif.), and J. Blamont (CNRS, Service d'Aéronomie, Verrières le Buisson, Essonne, France). *Geophysical Research Letters*, vol. 6, Sept. 1979, p. 743-746. 18 refs. Contract No. NAS2-9126.

Nitric oxide may be produced in the atmosphere of Venus by lightning storms in the clouds. The paper suggests that the odd nitrogen thus formed may play an important part in the chemistry of the clouds. Specifically, production rates for NO<sub>2</sub> in the limiting case of high NO concentrations are estimated. If the NO density is high, it is suggested that NO<sub>2</sub> may catalyse the production of sulfuric acid aerosol from sulfur dioxide and water vapor, and may also form nitrogen sulfur compounds such as nitrosyl sulfuric acid, NOHSO<sub>4</sub>. The large particles seen by the Pioneer Venus sounder probe may contain considerable quantities of NOHSO<sub>4</sub>. If this is the case, odd nitrogen must be present in the atmosphere in at least a parts-per-million mixing ratio. (Author)

**N79-31498#** National Aeronautics and Space Administration.

Ames Research Center, Moffett Field, Calif.

**ELECTRICAL SHORT LOCATOR Patent Application**

Gordon J. Deboo and David Joseph Devine, inventors (to NASA)

Filed 24 Aug. 1979 12 p

(NASA-Case-ARC-11116-1; US-Patent-Appl-SN-069485) Avail.

NTIS HC A02/MF A01 CSCL 09A

An electrical short finding instrument suited for locating shorts as they occur while an electrical system is being wired. sounds an alarm as soon as a short is produced and further identifies the conductors that are shorted together. A ring counter derives input pulses from a squarewave oscillator. The outputs of the counter are fed through transistors to an array of light emitting diodes. Each diode is connected to an electrical conductor, such as a bus bar, that is to be tested. Leads and connector permit such connections to be made to the bus bar assembly. In the absence of a short between two electrical conductors the diodes are sequentially illuminated. When a short occurs, a comparator/multivibrator circuit triggers an alarm and stops the oscillator and the sequential energization of the diodes. The two diodes that remain illuminated identify the bus bars that are shorted.

NASA

## PATENTS

**N79-18580\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**MINIATURE IMPLANTABLE ULTRASONIC ECHOSONOMETER Patent**

Gilbert K. Kojima, inventor (to NASA) Issued 29 Aug. 1978 7 p Filed 12 Jan. 1977 Supersedes N77-15621 (15 - 06. p 20786

(NASA-Case-ARC-11035-1; US-Patent-4,109,644.

US-Patent-Appl-SN-758721; US-Patent-Class-128-2V.

US-Patent-Class-128-2 05Z; US-Patent-Class-128-2 1A) Avail. US Patent and Trademark Office CSCL 06B

A miniature echosonometer adapted for implantation in the interior of an animal for imaging the internal structure of a organ, tissue or vessel is presented. The echosonometer includes a receiver/transmitter circuit which is coupled to an ultrasonic transducer. Power is coupled to the echosonometer by electromagnetic induction through the animal's skin. Imaging signals from the echosonometer are electromagnetically transmitted through the animal's skin to an external readout apparatus.

Official Gazette of the U.S. Patent and Trademark Office

R

**N79-26771\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**BIOMEDICAL ULTRASONOSCOPE Patent**

Robert D. Lee, inventor (to NASA) Issued 29 May 1979 12 p Filed 30 Sep. 1976 Supersedes N77-15619 (15 - 06. p 0786)

(NASA-Case-ARC-10994-2; US-Patent-4,154,230.

US-Patent-Appl-SN-759965; US-Patent-Class-128-660.

US-Patent-Class-73-626) Avail. US Patent and Trademark Office CSCL 06A

The combination of a C mode scan electronics in a portable, battery powered biomedical ultrasonoscope having A and M mode scan electronics. The C mode scan electronics comprises a plurality of transducer elements arranged in a row and adapted to be positioned on the skin of the patient's body for (1) converting a pulsed electrical signal to a pulsed ultrasonic signal, (2) irradiating the ultrasonic signal into the patient's body, (3) picking up the echoes reflected from interfaces in the patient's body, and (4) converting the echoes to electrical signals. Each transmitter is coupled to a respective transducer for transmitting a pulsed electrical signal and for transmitting the converted electrical echo signals directly to the receiver.

Official Gazette of the U.S. Patent and Trademark Office

# FEDERAL AVIATION ADMINISTRATION

## JOURNAL ARTICLES, BOOKS AND CHAPTERS OF BOOKS

A79-23581 \* Dynamic simulation studies of fuel conservation procedures used in terminal areas. P. J. O'Brien (FAA, National Aviation Facilities Experimental Center, Atlantic City, N.J.), L. Tobias, and E. A. Palmer (NASA, Ames Research Center, Moffett Field, Calif.). In: Air Traffic Control Association, Annual Fall Conference, 23rd, Fort Worth, Tex., October 2-5, 1978, Proceedings. (A79-23580 08-04) Washington, D.C., Air Traffic Control Association, Inc., 1978, p. 9-15.

A simulation program was devised to study the effects of fuel isolated rotor. However, if both rotors do not have the same blade geometry, rotating stall affects the whole compressor only if the first stage initiates it, and in the case of wall separation, this phenomenon is restricted to the stage in which it is initiated. (Author)

A79-45262 \* Acceleration of transonic potential flow calculations on arbitrary meshes by the multiple grid method. A. Jameson (New York, University, New York, N.Y.). In: Computational Fluid Dynamics Conference, Williamsburg, Va., July 23-25, 1979, Collection of Technical Papers. (A79-45251 19-34) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 122-146. 14 refs. Contracts No. N00014-77-C-0032; No. EY-76-C-02-3077; Grants No. NG-1579, No. NGR-33-016-201. (AIAA 79-1458)

A multiple grid method for transonic flow calculations is developed. The proposed scheme incorporates a generalized alternating direction method as the smoothing algorithm. Numerical experiments indicate that this multigrid alternating direction method converges rapidly and reliably for a range of cases typical of the cruising regime up to the onset of drag rise. It also appears that the method can be readily generalized to treat three-dimensional flows. B.J.

T

# U.S. ARMY RESEARCH AND TECHNOLOGY LABORATORIES

## FORMAL REPORTS

**N79-10029#** Army Research and Technology Labs., Moffett Field, Calif.

### VELOCITY MEASUREMENT ABOUT A NACA 0012 AIRFOIL WITH A LASER VELOCIMETER

Danny R. Hoad, Warren H. Young, Jr., and James F. Meyers  
Jun. 1978 15 p refs

(AD-A056447) Avail: NTIS HC A02/MF A01 CSCL 20/4

A laser velocimeter measured the velocity field about a wing with a NACA 0012 airfoil section. These measurements were compared at two low angles of attack (0 deg, 4.15 deg) with a two-dimensional viscous-flow prediction program. At 0 deg, the comparison provided confidence in the effectiveness and accuracy of the laser velocimeter. At 4.15 deg, the data indicated that a small laminar separation bubble with oscillating shear layer probably existed. The unique capability of the laser velocimeter in measuring absolute flow magnitude and direction without prior knowledge of general flow direction was demonstrated in the complex separated reverse flows over the wing at an angle of attack of 19.4 deg

GRA

Application of theories, as well as, special methods of procedures applicable to performance prediction are illustrated first, on an example of the conventional helicopter and then, winged and tandem configurations. Performance prediction of conventional helicopters in hover and vertical ascent are investigated. Various approaches to performance prediction in forward translation are presented. Performance problems are discussed only this time, a wing is added to the baseline configuration, and both aircraft are compared with respect to their performance. This comparison is extended to a tandem Appendices on methods for estimating performance guarantees and growth of aircraft concludes this volume

L S

**N79-22039#** Boeing Vertol Co., Philadelphia, Pa

### ROTARY-WING AERODYNAMICS. VOLUME 1: BASIC THEORIES OF ROTOR AERODYNAMICS WITH APPLICATION TO HELICOPTERS

W Z. Stepniewski Washington NASA Jan. 1979 302 p refs

(Contract NAS2-7007)

(NASA-CR-3082) Avail: NTIS HC A14/MF A01 CSCL 01A

The concept of rotary-wing aircraft in general is defined. The energy effectiveness of helicopters is compared with that of other static thrust generators in hover, as well as with various air and ground vehicles in forward translation. The most important aspects of rotor-blade dynamics and rotor control are reviewed. The simple physicomathematical model of the rotor offered by the momentum theory is introduced and its usefulness and limitations are assessed. The combined blade-element and momentum theory approach, which provides greater accuracy in performance predictions, is described as well as the vortex theory which models a rotor blade by means of a vortex filament or vorticity surface. The application of the velocity and acceleration potential theory to the determination of flow fields around three dimensional, non-rotating bodies as well as to rotor aerodynamic problems is described. Airfoil sections suitable for rotors are also considered

A R H

**N79-17516\*** Ohio State Univ., Columbus. Human Performance Center

### EVALUATION OF KINESTHETIC-TACTUAL DISPLAYS USING A CRITICAL TRACKING TASK

c54

Richard J. Jagacinski, Dwight P. Miller, Richard D. Gilson, and Robert T. Ault /in MIT Proc. 13th Ann. Conf. on Manual Control 1977 p 439-446 refs (For primary document see N79-17475 08-51)

(Grant NsG-2179)

Avail: NTIS HC A20/MF A01 CSCL 05H

The study sought to investigate the feasibility of applying the critical tracking task paradigm to the evaluation of kinesthetic-tactual displays. Four subjects attempted to control a first-order unstable system with a continuously decreasing time constant by using either visual or tactual unidimensional displays. Display aiding was introduced in both modalities in the form of velocity quickening. Visual tracking performance was better than tactual tracking, and velocity aiding improved the critical tracking scores for visual and tactual tracking about equally. The results suggest that the critical task methodology holds considerable promise for evaluating kinesthetic-tactual displays

L S

**N79-17811\*** Boeing Vertol Co., Philadelphia, Pa  
ROTARY WING AERODYNAMICS. VOLUME 2: PERFORMANCE PREDICTION OF HELICOPTERS Final Report

C. N. Keys and W. Z. Stepniewski ed Jan 1979 242 p refs

(Contract NAS2-7007)

(NASA-CR-3083) Avail: NTIS HC A11/MF A01 CSCL 01A

## JOURNAL ARTICLES, BOOKS AND CHAPTERS OF BOOKS

A79-29720 \* A comparison of kinesthetic-tactual and visual displays via a critical tracking task. R. J. Jagacinski, D. P. Miller, and R. D. Gilson (Ohio State University, Columbus, Ohio). *Human Factors*, vol. 21, Feb. 1979, p. 79-86. Army-sponsored research; Grant No. NsG-2179.

The feasibility of using the critical tracking task to evaluate kinesthetic-tactual displays was examined. The test subjects were asked to control a first-order unstable system with a continuously decreasing time constant by using either visual or tactual unidimensional displays. The results indicate that the critical tracking task is both a feasible and a reliable methodology for assessing tactual tracking. Further, that the critical tracking methodology is as sensitive and valid a measure of tactual tracking as visual tracking is demonstrated by the approximately equal effects of quickening for the tactual and visual displays.

S.D.

X

# AEROMECHANICS LABORATORY

## FORMAL REPORTS

N79-10864\*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AEROACOUSTIC RESEARCH: AN ARMY PERSPECTIVE**  
H Andrew Morse and Fredric H. Schmitz /n NASA Langley Res. Center Helicopter Acoustics, Pt 2 Aug 1978 p 797-817 refs Prepared in cooperation with Army Res. and Technol. Labs., Fort Eustis, Va. (For primary document see N79-10843 01-71) Avail. NTIS HC A19/MF A01 CSCL 20A

A short perspective of the Army aeroacoustic research program is presented that emphasizes rotary wing, aerodynamically generated noise. Exciting breakthroughs in experimental techniques and facilities are reviewed which are helping build a detailed understanding of helicopter external noise. Army and joint Army/NASA supported research programs in acoustics which promise to reduce the noise of future helicopters without severe performance penalties are included. J M S

N79-15977\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

**MISSION ENVIRONMENT SIMULATION FOR ARMY ROTORCRAFT DEVELOPMENT: REQUIREMENTS AND CAPABILITIES**

Y David L. Key, Billy L. Odneal, and John B. Sinacori /n AGARD Piloted Aircraft Environ. Simulation Tech. Oct 1978 17 p refs Prepared in cooperation with Army Aviation Res. and Develop Command, Moffett Field, Calif. (For primary document see N79-15973 07-09) Avail. NTIS HC A14/MF A01 CSCL 01E

The rich and varied detail visible in terrain flight must be presented by a wide field-of-view system with much detail and high resolution. The rotary-wing R&D simulator must have great versatility for easy change of cab configurations and the capability to accommodate a two or three man crew. Basic specifications for an adequate visual display were developed and are compared with current and forecasted techniques for image generation and presentation. Results of a study performed to determine the feasibility of meeting these requirements using the current technology of TV camera-model image generation and projected display are discussed and an assessment of the possibility that computer generated imagery can achieve the desired level of detail is presented. G Y.

N79-27084\*# Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.

**WIND TUNNEL TESTS OF FOUR FLEXIBLE WING ULTRA-LIGHT GLIDERS** c02

Robert A. Ormiston /n NASA Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun 1979 p 557-589 (For primary document see N79-27070 18-01) Avail. NTIS HC A99/MF A01 CSCL 01A

The aerodynamic lift, drag, and pitching moment characteristics of four full scale, flexible wing, ultralight gliders were measured in the settling chamber of a low speed wind tunnel. The gliders were tested over a wide range of angle of attack and at two different velocities. Particular attention was devoted to the lift and pitching moment behavior at low and negative angles of attack because of the potential loss of longitudinal stability of flexible wing gliders in this regime. The test results were used to estimate the performance and longitudinal control characteristics of the gliders. J A M

## NASA CONTRACTOR REPORTS

N79-20103\*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.

**THE ROLE OF ROTOR IMPEDANCE IN THE VIBRATION ANALYSIS OF ROTORCRAFT, PART 4 Final Report**  
Kurt H. Hohenemser Jun 1978 38 p refs Prepared for Army Aviation Res. and Develop. Command, Moffett Field, Calif. (Contract NAS2-7613) (NASA-CR-152261) Avail. NTIS HC A03/MF A01 CSCL 01C

A method for a strongly idealized case of vertical excitation and for rolling and pitching moment excitation of a four bladed hingeless rotor on an up-focussing flexible mount is developed. The aeroelastic rotor impedances are computed directly with a finite blade element method that includes aerodynamics. The rotor impedance matrix for three or more blades is determined from the root moment impedance for a single blade by a simple multiblade transformation rule. Force and moment amplitudes transferred from the rotor to support are found to be critically dependent on the support dynamics. S E S

N79-26883\*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics

**AERODYNAMIC SOUND GENERATION DUE TO VORTEX-AEROFOIL INTERACTION. PART 2: ANALYSIS OF THE ACOUSTIC FIELD**

R. Parasarathy and K. Karamcheti Sep 1972 75 p refs Sponsored in part by Army Mobility Res. and Develop. Command (Contract NAS2-6158) (NASA-CR-152231) Avail. NTIS HC A04/MF A01 CSCL 20A

The Lighthill method was the basic procedure used to analyze the sound field associated with a vortex of modified strength interacting with an airfoil. A free vortex interacting with an airfoil in uniform motion was modeled in order to determine the sound field due to all the acoustic sources, not only on the airfoil surfaces (dipoles), but also the ones distributed on the perturbed flow field (quadrupoles) due to the vortex-airfoil interaction. Because inviscid flow is assumed in the study of the interaction, the quadrupoles considered in the perturbed flow field are entirely due to an unsteady flow field. The effects of airfoil thickness on the second radiation are examined by using a symmetric Joukowski airfoil for the vortex-airfoil interaction. Sound radiation in c plane, far field simplification, and computation of the sound field are discussed. A R H

## JOURNAL ARTICLES, BOOKS AND CHAPTERS OF BOOKS

A79-18653 \* # The role of rotor impedance in the vibration analysis of rotocraft. K. H. Hohenemser (Washington University, St. Louis, Mo.) and S.-K. Yin (Bell Helicopter Textron, Fort Worth, Tex.). In: European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings, Volume 1. (A79-18637 06-01) Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 17-0 to 17-34. 14 refs. Contract No. NAS2-7613.

In an improved method which retains the advantage of separate treatment of rotor and airframe, the rotor impedance is used to correct the input to the airframe. This improved method is illustrated for a strongly idealized case of vertical excitation and then for rolling and pitching moment excitation of a four bladed hingeless rotor on an up-focusing flexible mount. Contrary to the usual approach that represents aeroelastic blade motions by a series of normal blade modes in vacuum, the aeroelastic rotor impedances are computed directly with a finite blade element method that includes aerodynamics. The rotor impedance matrix for three or more blades is determined from the root moment impedance for a single blade by a simple multiblade transformation rule. Force and moment amplitudes transferred from the rotor to the support are found to be critically dependent on the support dynamics. (Author)

A79-19792 \* # Viscous flow analysis in mixed flow rotors. I. Khalil, W. Tabakoff, and A. Hamed (Cincinnati University, Cincinnati, Ohio). American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec. 10-15, 1978, Paper 78-WA/GT-3, 15 p. 18 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. NAS2-7850.

A method for analyzing the viscous flow through turbomachine rotors is presented. The field analysis is based upon the solution of the full Navier-Stokes equations over the rotor blade-to-blade stream channels. An Alternating-Direction-Implicit method is employed to carry out the necessary numerical integration of the elliptic governing equations. The flow analysis may be applied to various types of turbomachine rotors. Preliminarily, only the case of laminar flows are considered in this paper. The flow characteristics within the rotors of a mixed flow turbine and a radial bladed compressor are investigated over a wide range of operating conditions. Excellent results are obtained when compared with existing experimental data. The method of this analysis is quite general and can deal with a wide range of applications. Possible modification of the present study to deal with turbulent flow cases are also identified. (Author)

A79-22475 \* Parameter identification applied to analytic hingeless rotor modeling. D. Banerjee (Hughes Helicopters, Culver City, Calif.), S. T. Crews (U.S. Army, Systems Development and Qualification Div., St. Louis, Mo.), and K. H. Hohenemser (Washington University, St. Louis, Mo.). American Helicopter Society, *Journal*, vol. 24, Jan. 1979, p. 26-32. 15 refs. Army-sponsored research. Contract No. NAS2-7613.

It is known that dynamic rotor inflow has a substantial effect on rotor dynamic loads. Despite the complexity of the unsteady flow problem, simple analytical models can be made useful by identifying their parameters from transient response tests without performing flow measurements. Two analytical inflow models are studied: the first is based on an equivalent blade Lock number, the second is based on a time delayed unsteady momentum inflow. In preparation for the experimental data analysis, identifications from simulated test data and an eigenvalue analysis are performed. The experimental results show that the first analytical inflow model is accurate for rotor advance ratios of 0.4 and above. For lower advance ratios, the second inflow model provides better accuracy. Prediction studies with experimental data not used for the identification are performed to determine the accuracy of the mathematical models. (Author)

A79-24213 \* # Water tunnel visualizations of dynamic stall. K. W. McAlister and L. W. Carr (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: Nonsteady fluid dynamics; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. (A79-24201 08-34) New York, American Society of Mechanical Engineers, 1978, p. 103-110. 8 refs.

A two-dimensional experiment was conducted in a water tunnel using hydrogen bubble flow visualizations for the purpose of exposing, independently, the behavior of the viscous and inviscid domains during unsteady airfoil stall. By imposing a large amplitude pitch oscillation about the static-stall angle of a modified NACA 0012 airfoil, an unsteady environment was created that not only altered considerably the progression of flow reversal along the airfoil surface from what was observed in steady flow, but also caused a unique succession of vortical developments to appear that is unparalleled in steady flow. More importantly, the first stage of dynamic stall was found to be the rapid spread of a thin region of reversed flow over the entire upper surface of the airfoil, which momentarily created a free-shear layer without any appreciable disturbance of the viscous-inviscid boundary. This free-shear layer broke down rapidly into a multitude of discrete vortices that eventually coalesced to produce a dominant shear-layer vortex, followed by a dynamic-stall vortex. (Author)

A79-29005 \* # Vibration and response of nonuniform rotating beams with discontinuities. D. H. Hodges (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: Structures, Structural Dynamics, and Materials Conference, 20th, St. Louis, Mo., April 4-6, 1979, Technical Papers on Structures and Materials. (A79-29002 11-39) New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 29-38. 13 refs. (AIAA 79-0731)

The direct analytical method of Ritz is applied to solve for the modal frequencies, mode-shapes, and response of a nonuniform rotating beam with discontinuities in bending stiffness and mass distribution. Unlike conventional modal methods, however, separate series of admissible functions are assumed within segments of the beam that are free from discontinuities in stiffness and mass properties. Results are obtained that converge to the exact solution so that bending moment and shear force distributions can be expressed simply and accurately in terms of derivatives of the displacement. Results from this method are compared with those from conventional Rayleigh-Ritz methods and found to be superior in terms of accuracy and simplicity. (Author)

A79-38136 \* # Aeroelastic stability analysis of the AD-1 manned oblique-wing aircraft. M. J. Rutkowski (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). *Journal of Aircraft*, vol. 16, June 1979, p. 401-406. 23 refs.

The AD-1 manned flight test program being conducted jointly by the Ames and Dryden Flight Research Centers of NASA is intended to evaluate the stability, control, and handling characteristics of oblique-wing aircraft. The results of the aeroelastic stability analysis carried out at Ames in support of the AD-1 program are presented for the oblique wing, both with and without ailerons. When the wing is swept, the significant mode of instability is low-frequency, oblique-wing flutter. With the oblique unswept, however, the critical mode is bending-torsion-aileron flutter. The latest version of the NASTRAN computer code, as well as the Ames PASS/FLUT program, was used in these studies. (Author)

A79-46063 \* # Direct solutions for Sturm-Liouville systems with discontinuous coefficients. D. H. Hodges (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). *AIAA Journal*, vol. 17, Aug. 1979, p. 924-926.

The Ritz direct method is applied to a class of Sturm-Liouville structural vibration problems with discontinuous coefficients. Terms of a power series are used as admissible functions within segments of the domain that are chosen to have all discontinuities at their

extremities. Only geometric boundary conditions are satisfied by the admissible functions, chosen to be terms of a power series, and geometric continuity is enforced at the segment boundaries. B.J.

**A79-49060 # A system for interdisciplinary analysis - A key to improved rotorcraft design.** A. W. Kerr (U.S. Army, Research and Technology Laboratories, Moffett Field, Calif.) and J. M. Davis (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. (A79-49053 21-01) Washington, D.C., American Helicopter Society, 1979. 15 p. 16 refs. (AHS 79-8)

Development of the Second Generation Comprehensive Helicopter Analysis System (2GCHAS) is being initiated by the U.S. Army Research and Technology Laboratories. This system provides the capability to model the total helicopter to predict performance, loads, vibration, aeroelastic stability, stability and control, and acoustics characteristics. This interdisciplinary analysis system is a basic tool required to support the rotorcraft design process. Aspects of this system which affect its application as a design tool are addressed. A primary consideration in the development of the system is the manner in which component parts of the helicopter are combined analytically to represent the total vehicle system. The results of a workshop conducted to discuss formulation of equations and related issues are summarized. Requirements to make the system easy to use are explored, including the manner in which it is applicable through all phases of aircraft design and development from conceptual analysis through flight test and detailed modification support.

(Author)

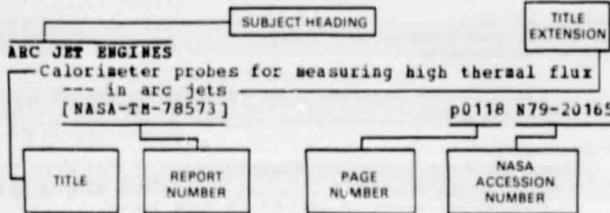
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**SECTION II**

**INDEXES**

# SUBJECT INDEX

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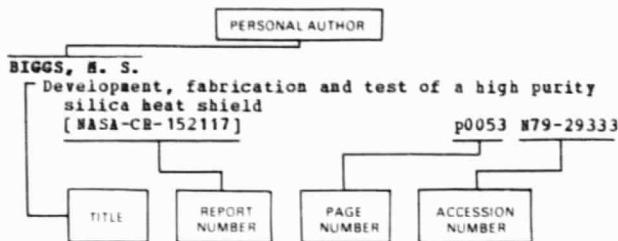
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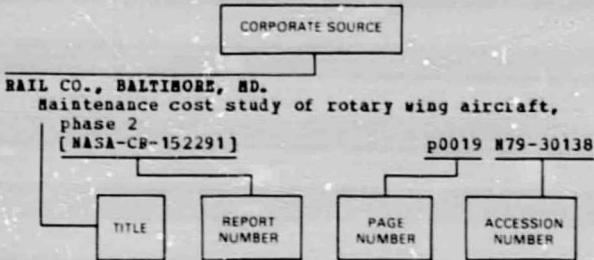
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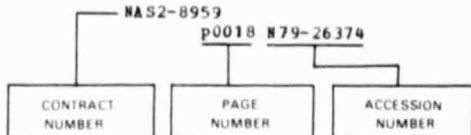
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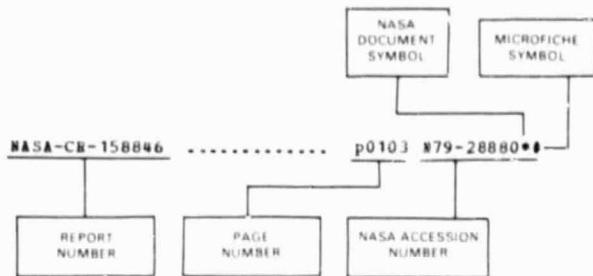
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